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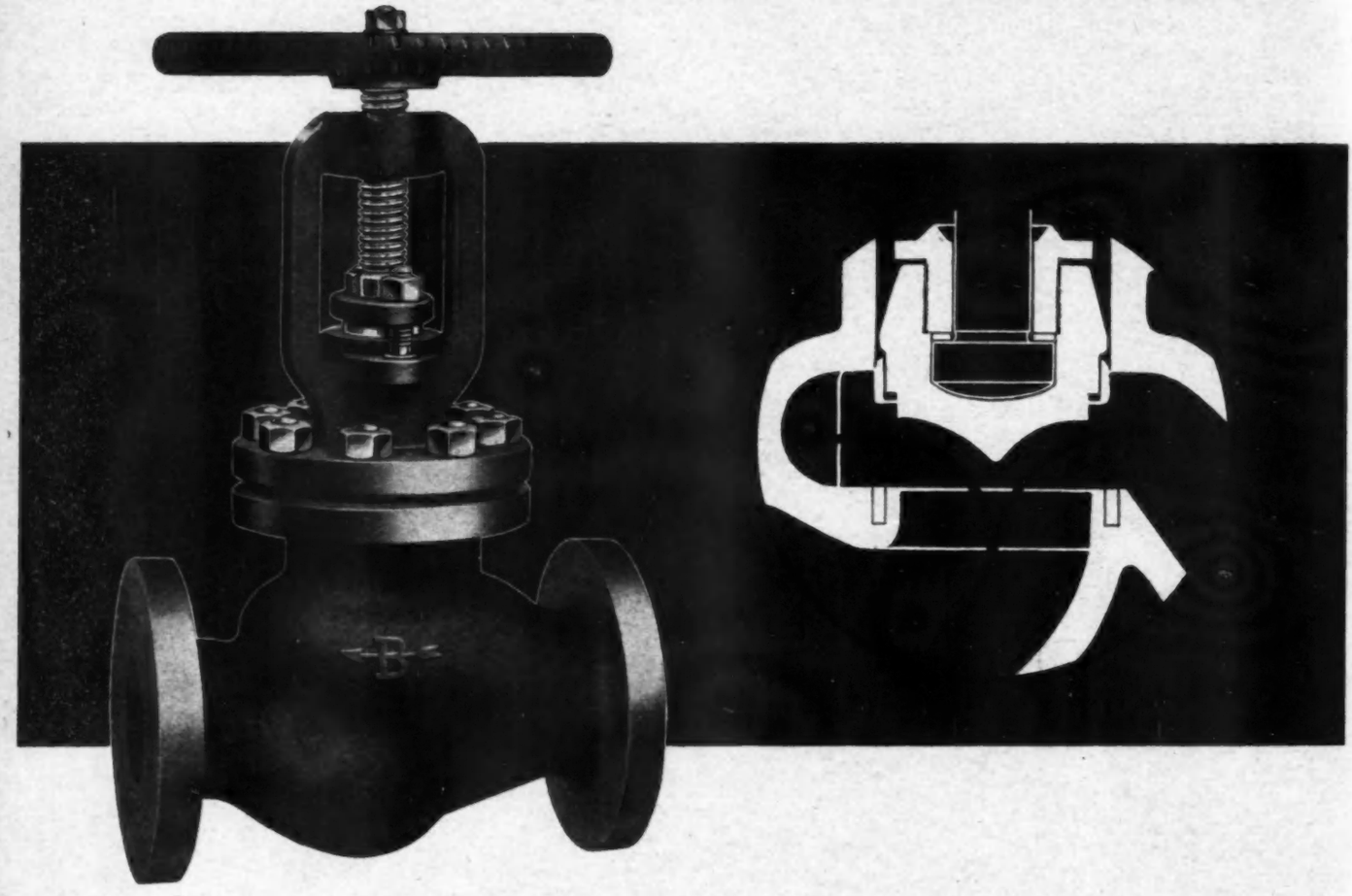

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CONCRETE-AGGREGATE HANDLING PLANT.

As an addendum to the recent series of articles on dam construction in the Tennessee Valley, we give below a description of the interesting concrete-aggregate handling plant which was used in the building of the Guntersville Dam. This dam is situated 74 miles above the Wheeler Dam, at the head of the pool created by the latter, as shown in Fig. 1, on page 1, *ante*. It was completed last year. Before dealing with the plant which is the main subject of this article, a brief description of the dam itself may be given. As will be seen from the aerial view, reproduced in Fig. 1, on this page, it follows the Pickwick Landing Dam (shown in Fig. 47, on page 161, *ante*) in general layout. There is a navigation lock situated at the north bank of the river, and this is followed by a spillway section, 856 ft. long, with a power-house structure next to the south bank. The concrete dam is flanked by an earth embankment on each side of the river, these extending across the flood plain to higher ground on each side. The total length, including the earth embankments, is 3,985 ft. The reservoir formed by the dam has a capacity of 242,000 acre-ft. and the spillway is designed to deal with a flood of 625,000 cusecs; the maximum recorded flood is 455,000 cusecs.

Work was begun on the dam in January, 1936, and it was built in three stages. The first covered the navigation lock for which 124,000 cub. yd. of concrete had to be supplied; the second, 15 sections of the spillway, involving the laying of 62,000 cub. yd. of concrete; and the third the remaining three sections of the spillway and the power-house and intake structures. These latter contain 115,000 cub. yd. of concrete. The work was carried out inside cellular sheet-pile cofferdams of the type which were used at the Pickwick Landing Dam and which are described on pages 161 and 201, *ante*. The cofferdam erected around the lock site is shown in the plan of the work which is reproduced in Fig. 2, on page 243. The third cofferdam can be seen in the distance in Fig. 1, which shows the dam during the building of the power-house structure.

A fixed aggregate and concrete-mixing plant was used for all three stages of the work. This was located on the north bank of the river, downstream from the dam, as shown in Fig. 2. It can be seen in the centre foreground of Fig. 1. The aggregate was won from the river bed, at a point some distance from the dam, by means of a Diesel-electric dredge, and was delivered through a 16-in. floating pipe line to a screening plant mounted on a barge. By this it was graded to five sizes and loaded into barges which were towed to the site of the dam. Three of these barges are indicated alongside the timber-crib unloading quay in Fig. 2, and two of them can be seen in Fig. 9, on page 250, which is a general view of the aggregate-handling plant. The quay is on the right in this figure, and the lock under construction, inside No. 1 cofferdam, can be seen behind it.

The aggregate was unloaded from the barges by a revolving electric crane with a 95-ft. jib, which carried a 2-cub. yd. clamshell bucket. The crane, which is shown in Figs. 2 and 9, travelled on a wide-gauge rail track laid at an angle of about 60 deg. to the line of the quay and extended outwards beyond the river bank on pile bents. It delivered to a 150-ton hopper situated at the river bank, and by traversing it along its track, to a position to suit the particular barge being dealt with, it was possible to carry out the unloading without it being necessary to luff the jib when under load. The hopper, which is shown in Figs. 2 and 9, was fitted with a gate which controlled the discharge to a vibrating feeder. The latter regulated the flow of the material on to a 30-in. belt conveyor by which it was carried to the storage plant. This belt conveyor is indicated as Flight A in Fig. 2. It can also be seen in Fig. 9, from which it will be noted that somewhere near its central point the conveyor passed through a tunnel where it crossed the roadway along the river bank. This conveyor was 443 ft. long and had a capacity of 400 tons an hour.

The aggregate storage and reclaiming plant which was constructed to the design of the Tennessee Valley Authority engineering staff, consisted of a radial stacker by which the material for storage was distributed around a central tower in five independent heaps, each consisting of one type of aggregate. The five heaps are indicated by the five-lobed area shown in Fig. 2. Some of them can be seen at the left of Fig. 9, but they are better shown in the general view of the stacker given in Fig. 10, on page 250. The plant also included a series of four conveyors by which the aggregate was delivered from the quay hopper to the concrete-mixing plant. These conveyors are shown in Fig. 2, but the function of each will be best explained by following through the operation of the plant in detail.

The steel tower, in the centre of the stacking area, was 113 ft. high and was supported by guy ropes carried clear of the aggregate heaps. It was mounted on a concrete pedestal, and around its base was a circular hopper to which material transported from the quay hopper by the first conveyor, Flight A, was delivered. The inner end of this conveyor, connecting to the tower, is shown in Fig. 3, on Plate XIX. The hopper was provided with a delivery chute fitted with a flap gate by means of which aggregate could be passed to a stacker boom, which distributed it over the storage area, or to the second conveyor, Flight B, Fig. 2. In this latter case the material by-passed the storage system and was delivered directly to the concrete plant. The stacker boom can be seen, lying in a horizontal position, to the left of the tower in Fig. 3. At the inner end, it was attached to a 22-ft. diameter bull wheel which was supported on rollers and travelled on a circular rail extending round the base of the tower. The outer end of the boom was supported by a nine-part tackle, attached to it at two points, and connected to the top of the tower. This enabled it to be secured in any position up to a maximum slope of 22 deg. from the horizontal. The boom was not able to make a complete revolution around the tower, since it would have fouled the first conveyor, as will be obvious from Fig. 3. Its arc of movement was, however, sufficient to enable the whole of the storage ground to be stacked, as shown in Fig. 10. The boom can be

FIG. 1. GUNTERSVILLE DAM ON TENNESSEE RIVER, DURING CONSTRUCTION.

seen, in an inclined position, to the left of the tower in this figure.

The boom carried a 30-in. reversible belt conveyor, 160 ft. long, so that the material delivered to it from the tower hopper could be transported to the storage areas. The boom carried a series of movable ploughs which could be lowered on to the belt, causing the material being transported to be thrown off at any desired point, so that the aggregate could be built up in heaps over the whole of the storage ground. The boom was rotated around the tower by a 30-h.p. electric motor, the luffing motor being of 100 h.p., and the conveyor motor of 40 h.p. The storage ground was approximately 500 ft. in diameter, and the five sectors into which it was divided had capacities, respectively, of 34,700 tons of fine sand; 34,700 tons of coarse sand; 47,200 tons of pea gravel; 52,500 tons of ¾-in. to 1½-in. gravel; and 31,100 tons of 1½-in. to 4-in. gravel. The various sections of the storage area were separated by wooden barriers. It will be understood, of course, that no separating or screening was done by this handling plant, the various classes of aggregate arriving at the unloading quay in separate barges, and being transferred to the appropriate heaps.

Material was reclaimed from the storage ground by means of a crane carried on chain-tracks and operating on the outside of the storage heaps. It can be seen in Fig. 10. The crane was fitted with a 1½-cub. yard clamshell bucket, by means of which the aggregate was loaded into a hopper, carried at the outer end of the distributing boom. This is clearly shown in Fig. 4, on Plate XIX, in which the end of the boom can be seen at the right-hand side. During this operation, the boom rested in a horizontal position, on a 10-ft. high supporting frame, which is shown in Fig. 4. The frame was swung into position by the reclaiming crane. By reversing the direction of movement of the boom conveyor, the material was transported from the hopper to the base of the tower, where it was delivered to the second main conveyor, Flight B, Fig. 2, and carried to the aggregate bins situated at the east end of the storage ground. Flight B conveyor, which had a 30-in. belt and was 298 ft. long, is shown in the background of Fig. 4. The total capacity of the storage area was 225,000 tons, this large reserve enabling any of the three construction stages of the dam to be carried on without interruption during periods in which the height of the river made it impossible to operate the dredger by which the aggregate was won. All conveyors throughout the storage plant had capacities of 400 tons an hour, this being the maximum delivery capacity of the dredging or screening plant.

It will be clear that this main storage plant was not adapted to supply any particular type of aggregate immediately on demand, and that some form of intermediate storage was necessary between it and the concrete-mixing plant. This was furnished by the group of five aggregate bins shown to the east of the stacking area in Fig. 2, and already referred to. They were of octagonal form, constructed of timber, and had a capacity of 2,300 tons, which was about sufficient for one day's production of concrete. The bins are clearly shown on the left of Fig. 4. They can also be seen in Figs. 1 and 9. Flight B conveyor, from the storage ground, delivered to a small hopper situated above the aggregate bins. From this, each type of aggregate was delivered to the appropriate bin by a 30-in. belt conveyor, which was pivoted under the hopper so that it could be swung to deliver to any bin. This conveyor, which constituted Flight C of the series, was 26 ft. long and was too small to be clearly shown in the illustrations, but its position is indicated in Fig. 2.

Each of the aggregate bins was provided with a gate, through which material could be supplied to Flight D conveyor, leading to the mixing plant. This conveyor, which was 520 ft. long, had a 24-in. belt and a capacity of 250 tons an hour. It fed service bins situated at the top of the mixing plant, which was assembled in a tower, the arrangement being similar to that described in connection with the Norris Dam, on page 42, *ante*. The tower can be seen in Figs. 5 and 6, on Plate XIX, which also show the delivery end of Flight D conveyor. The last stage of the long conveyor system carried the mixed concrete to the dam works. The position of this, Flight E, conveyor was varied from time to time to suit the working conditions on the dam. In Fig. 2 it is shown in the position in which it delivered concrete for the building of the lock. Two views of the conveyor which had a 36-in. belt and was 210 ft. long, are reproduced in Figs. 7 and 8, on Plate XIX. The first of these shows the point at which it passed under the roadway leading to the river ferry landing stage, which is shown in Fig. 2 at the downstream end of the works. The second shows the delivery end at the lock. It will be noted that when this photograph was taken the lock works were flooded out, owing to high-river conditions. The footbridge on the right is under water. This conveyor had a capacity of 304 tons per hour.

The service bins at the top of the mixing-plant tower had a combined capacity of 500 cub. yd. of aggregate and as close control of the supply was necessary, the gate operator at the intermediate bins was kept in touch with the men working the mixing plant by means of a signal system. In emergencies requiring the supply of some particular class of aggregate in quantity or without delay, the intermediate bins could be by-passed, the material flowing directly from Flight B to Flight D. Interlocking controls throughout the plant prevented the starting of any conveyor unless the one ahead of it was in motion, in order to prevent the piling-up of material on a stationary belt. The controls were divided into two independent systems, one covering all conveyors from the quay hopper to the stacking boom, and the other those between the stack piles and the mixing-plant bins. The stacker boom and conveyors of this interesting plant were supplied by the Barber-Greene Company, of Aurora, Ill., and the tower and its appurtenances by the American Hoist and Derrick Company.

LITERATURE.

Elements of Acoustical Engineering. By DR. HARRY F. OLSON. London: Chapman and Hall. [Price 30s.]

THOUGH the author states in his preface that the subject matter of this book was prepared for lecture presentation at Columbia University, the work itself is more of a handbook for technicians than a text for students in the generally accepted sense of the term. The fact that many of the results are quoted without being derived does not, however, detract from their usefulness, since they are presented in a directly utilisable form with the meaning of each symbol explicitly stated, together with the units in which the corresponding quantity is to be measured. Such gaps as there are can be made good by consulting the well-chosen list of references provided. The space thus saved enables something relevant concerning nearly every type of acoustic or electro-acoustic system to be included in a matter of some 335 pages. It also permits the presentation of a large number of valuable graphs, on many of which theoretical findings are exhibited alongside experimental data.

An introductory account of the propagation of sound waves is followed by a discussion of such acoustical radiating systems as the point source, the doublet, the line source and the vibrating piston, located either in a plane wall or at the throat of a horn. The main mechanical vibrating systems—stretched strings, tensed membranes, rods, plates and pipes—are then briefly considered. Chapter IV, which deals with electrical, mechanical and acoustical analogies, is noteworthy in itself and fundamental to what follows, since, throughout the remainder of the work, the formal analysis is presented almost exclusively in terms of the equivalent electric circuit theory. The physical principles underlying the operation of corrective networks and wave filters is admirably brought out. In the next chapter, the components of the "acoustical circuit" are considered in detail, and essential results relating to the transmission of sound along tubes, through horns and across the interfaces separating different media are obtained. A short discussion of the various types of driving systems leads to two chapters in which loud speakers of the cone and horn type are thoroughly treated. In systems designed for the electrical reproduction of sound some form of microphone is employed in conjunction with the loud speaker, and Chapter IX describes and examines the properties of representative microphones designed to satisfy a diversity of what are often conflicting requirements. Instruments such as the telephone receiver, the gramophone and hearing aids are considered in a group under the heading of "Miscellaneous Transducers." The many methods of measurement involved in the calibration of instruments and the testing of components are adequately covered in Chapter XI, and, in this connection, it is interesting to notice how many basic acoustical measurements are made in terms of electrical quantities. As much of the advantage gained by improving the quality of a sound-reproducing system would be sacrificed if the system were set to function under adverse conditions, the study of architectural acoustics is obviously of great importance, and to this subject Chapter XII is devoted. Finally, the ear of the auditor being the final judge of the success of any acoustical appliance, the concluding chapter is appropriately occupied mainly with a discussion of the human hearing mechanism, though some consideration is also given to the mechanism of speech.

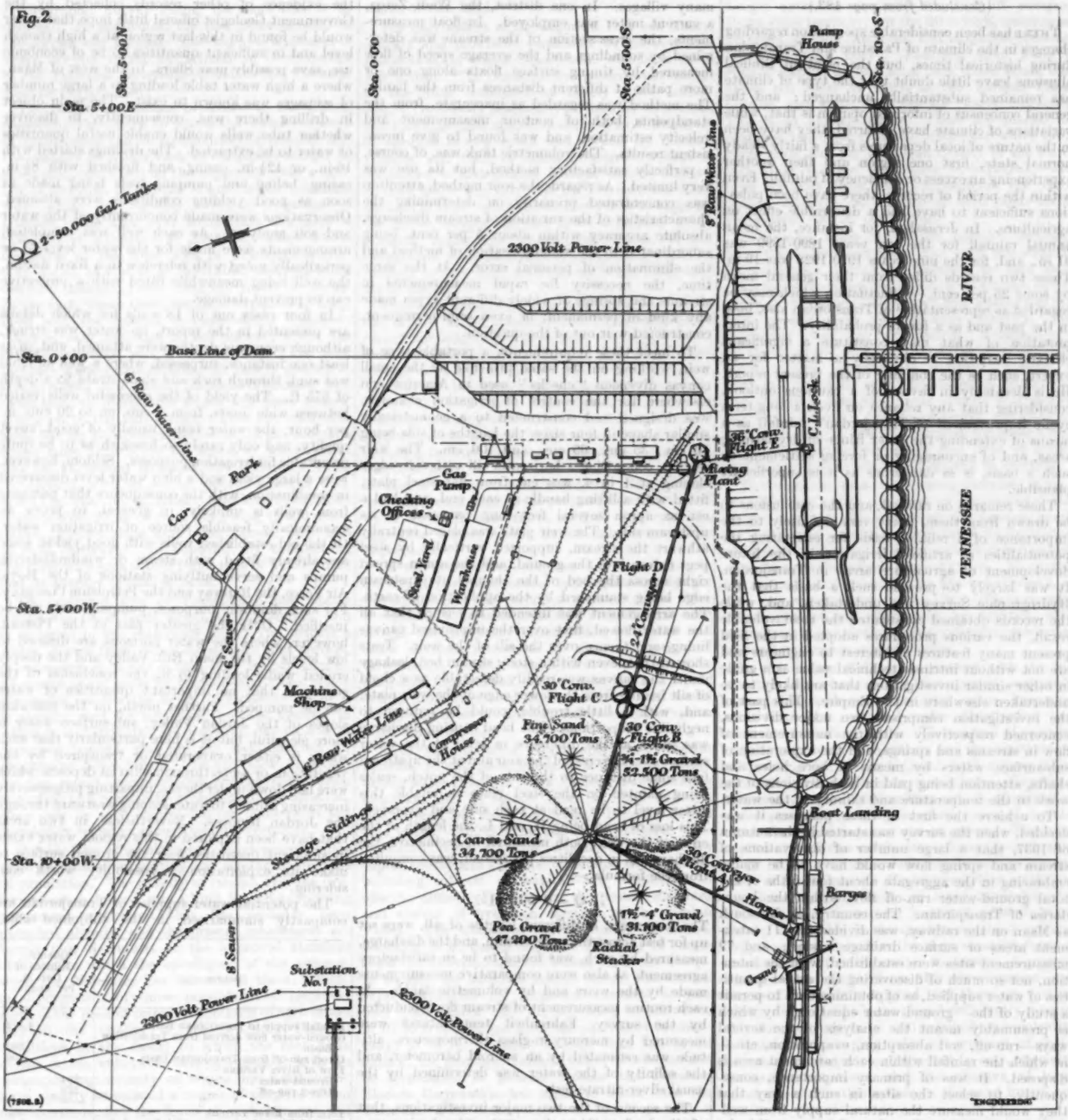
A somewhat large number of misprints was noted, particularly in the early part of the text. Some are obvious verbal slips, such as "end connection" for "end correction" on page 47; and "unit sand" for "units and" on page 221. Others relate either to symbols in formulæ, such as the redundant z in the expressions at the top of page 5, the c in equation (1·20) and the $\frac{p^2}{U^2}$ which appears in place of $\frac{p_2}{U_2}$ in equation (5·52); or to the specification of the units in which the corresponding quantities are to be measured, as on pages 88 and 184, where cm. appears in place of cm. per sec., and on page 249, where dynes per cm. appears in place of dyne cm. A few expressions, such as the "cube of dimensions Δx, Δy and Δz" on page 4, and the "acceleration of momentum" on page 5, need revision. Among the numerical inaccuracies are the 560 db. on page 256, which should presumably read 56 db.; and three errors in the tabulated data. Though the 0·2261 in the table on page 39 dates back to Seebeck (1848) and has been copied without check in nearly every subsequent acoustical text, the correct value is 0·2165. Again, in the last line of the table on the following page, ·05 should read 0·5, and on page 335 the relative frequency corresponding to F in the tempered scale should be 1·335 instead of 1·325. These minor defects apart, however, this book provides a thoroughly up-to-date survey of the whole field of acoustical engineering, and presents it attractively and methodically. To those engaged in the design and maintenance of acoustical equipment it will prove invaluable.

Mechanism and the Kinematics of Machines. By W. STEEDS, B.Sc.(Eng.), A.M.I.Mech.E. London: Longmans, Green and Company. [Price 18s. net.]

BY its very nature the study of mechanism is fundamental to the training of mechanical engineers. It is a large subject, rooted in classical geometry, kinematics and dynamics, yet still putting forth new branches. The designer of a new text-book on the theory of machines is confronted, therefore, with two considerable problems. He has to decide, first, upon the directions in which the most important advances in mechanical engineering are taking place, so as to meet the needs of the immediate future; and with this implicit objective in mind, he faces the second problem of selecting from an abundance of material everything that is basic and necessary, and excluding such as is merely academic or of waning practical value. The author of the present book has fulfilled these requirements with conspicuous success. Guided by his experience as lecturer in mechanical engineering at the Military College of Science, he covers the introductory, analytical kinematics of points, bodies and machines, as far as the study and derivation of velocities and accelerations, in a style that stimulates by its emphasis on fundamental principles of good mechanical design. The derivation and application of

CONCRETE-AGGREGATE HANDLING PLANT; GUNTERSVILLE DAM.

(For Description, see Opposite Page.)



Corioli's law, for example, are treated at length, while the basic ideas of freedom and constraint underlying kinematic design are given the attention they deserve. The latter part of the book links theory to application in a conventional range of mechanisms from the crank and connecting rod to the swash-plate, by way of straight-line motions, gears, belt-drives, couplings, ratchets and cams. The author steers a middle course between unduly analytical treatment and over-comprehensiveness; his descriptions of mechanisms, in fact, are commonly so brief as to demand constant mental agility on the part of the reader. Numerous exercises supplement the text.

Notable omissions from the scope of Mr. Steed's book are valve-gears and governors, while many readers will regret the absence of even an elementary study of balancing. The value of the book would undoubtedly be enhanced by chapters on these subjects, perhaps at the expense of certain rarely-used devices actually described. For the mature student and the designer, a fuller bibliography, especially relevant to recent scientific research papers, would increase its utility as a source of reference. Despite these limitations, it remains a sound text-book with more to be commended and less to be criticised than is the case with most of its kind.

EXPORTS OF RUBBER FROM BRITISH MALAYA.—Exports of rubber from Singapore, Penang, Malacca, and Port Swettenham, during February, amounted to 47,036 tons, and exports of latex in various forms to 523 tons.

"BASIC REFRACTORIES."—We have received from Messrs. John G. Stein and Company, Limited, Bonnybridge, Stirlingshire, a copy of a pamphlet entitled "Basic Refractories," dealing with the properties and uses of the six brands of magnesite, chrome, and chrome-magnesite refractory bricks and cements which they manufacture for the linings of open-hearth, reverberatory, reheating and other furnaces, kilns, converters, etc. The technical data given for each brand include the apparent porosity, permeability, cold crushing strength, spalling resistance index, thermal expansion and after-contraction, and a curve showing the refractoriness under load. A series of diagrams, coloured to indicate the brands recommended for particular situations, covers more than a dozen typical applications. A section on thermal expansion gives the allowances for the different compositions of bricks and also illustrates the method of using steel sheets in the horizontal joints of the vertical back wall of a furnace as a bracing against accidental damage.

THE WATER RESOURCES OF TRANSJORDAN.

(*Concluded from page* 183.)

THERE has been considerable speculation regarding changes in the climate of Palestine and Transjordan during historical times, but the plentiful Biblical allusions leave little doubt that the type of climate has remained substantially unchanged; and the general concensus of informed opinion is that, while variations of climate have occurred, they have been in the nature of local departures from a fairly steady normal state, first one region and then another experiencing an excess or deficiency of rainfall. Even within the period of records, there have been pulsations sufficient to have had a discernible effect on agriculture. In Jerusalem, for instance, the mean annual rainfall for the ten years 1890-1899 was 31 in., and, for the nine years 1920-1928 was 19 in. These two records differ from their general mean by some 25 per cent.—a fluctuation which may be regarded as representative of Transjordan also, both in the past and as a future probability. The interpretation of what may constitute a significant climatic variation is obviously a matter for an expert, such as the compiler of the present report. He is decidedly in favour of a cautious outlook, considering that any reliance on even a long-term cyclic improvement of Transjordan's rainfall as a means of extending the outer fringe of dry-farming areas, and of encouraging or forcing settlement on such a basis, is as dangerous as it is superficially plausible.

These remarks on rainfall, and the conclusions to be drawn from them, point very definitely to the importance of a reliable basis for estimating the potentialities of artificial irrigation in the future development of agriculture areas in Transjordan. It was largely to provide such a basis that the Hydrographic Survey was undertaken, and, while the records obtained constituted the most valuable result, the various procedures adopted in the field present many features of interest to engineers and are not without intrinsic technical value as a guide in other similar investigations that are likely to be undertaken elsewhere in the Empire. This part of the investigation comprised two major divisions, concerned respectively with the measurement of flow in streams and springs, and the exploration of sub-surface waters by means of bore holes and shafts, attention being paid in both divisions of the work to the temperature and salinity of the water.

To achieve the first of these purposes it was decided, when the survey was started in the autumn of 1937, that a large number of observations of stream and spring flow would have to be made, embracing in the aggregate about four-fifths of the total ground-water run-off flow within the boundaries of Transjordan. The country, as far south as Maan on the railway, was divided into 11 catchment areas or surface drainage basins; and 79 measurement sites were established, with the intention, not so much of discovering the actual quantities of water supplied, as of obtaining data to permit a study of the "ground-water equation," by which is presumably meant the analysis of the several ways—run-off, soil absorption, evaporation, etc.—in which the rainfall within each catchment area is disposed. It was of primary importance, consequently, to select the sites in such a way that they would measure the natural supply from well-defined sources, unaffected as far as possible by natural or artificial influences subsequent to their emergence, so that they might reflect accurately the variations in the ground-water from which they flowed. As illustrating the sort of conditions against which these precautions were directed, it is instructive to contrast the straightforward case of a spring of moderate size, emerging from a well-defined rock stratum, with that of a deep-seated constant spring which mixes, before emerging through river-bed gravels, with the shallow water from a transient wet-weather spring, dividing at once into a number of channels, each carrying an ill-defined proportion of the combined water.

Of the three methods—float, volumetric tank and steel weir—used for measurements of spring and stream flow, the last was generally preferred. Floats were used only when the discharge was so great as to make portable weirs impracticable, while volumetric tanks served only for such small discharges as issue from the drinking fountains to be found in many villages. In one district, the Wadi Zerqa, a current meter was employed. In float measurements, the cross-section of the stream was determined by soundings and the average speed of flow measured by timing surface floats along one or more paths at different distances from the banks. The method was regarded as inaccurate, from the standpoints both of contour measurement and velocity estimation, and was found to give inconsistent results. The volumetric tank was, of course, a perfectly satisfactory method, but its use was very limited. As regards the weir method, attention was concentrated primarily on determining the characteristics of the variation of stream discharge, absolute accuracy within about 5 per cent. being subordinated to the standardisation of method and the elimination of personal error. At the same time, the necessity for rapid measurements in streams and springs of widely different types made any kind of permanent, or even semi-permanent, constructed weir out of the question.

To meet these requirements, a portable type of weir, working on the same principle as the small canvas diversion "checks" used in America and elsewhere for the control of irrigation channels, was designed and constructed to a geometrically similar shape in four sizes, the lengths of sills being 16 cm., 35 cm., 65 cm., and 100 cm. The weir section, comprising a horizontal sill with side edges sloping at 1 in 4, was cut from flat steel plate, fitted with a lifting handle at each end, and had a canvas apron several feet long battened to its upstream side. The weir plate was placed centrally athwart the stream, supported vertically by steel pegs driven into the ground, and the apron spread right across the bed of the channel, its upstream edge being staunched by the application of earth. The arrangement was intended to ensure that all the water flowed, first over the improvised canvas lining, and thence over the sill of the weir. Tests showed that, even with a stony stream bed, leakage under the canvas was readily detectable as a cloud of silt issuing from the lower edge of the weir plate, and, with a little trouble, could be reduced to negligible proportions. The head causing discharge was taken as the difference in level of the water surface over the crest of the weir and at the upstream face some distance to the side of the notch, scales being painted on the steel plate to enable this latter level to be read at each side and averaged. This loss of head being H, and L, the length of the crest of the weir, both measured in decimetres, the discharge Q, in decalitres per second, was computed from the formula:—

$$Q = 0{\cdot}59\,L\,H^{\frac{3}{2}}.$$

The four weirs, of different lengths of sill, were set up for test across the same stream, and the discharge, measured by each, was found to be in satisfactory agreement, as also were comparative measurements made by the weirs and by volumetric tanks. At each routine measurement of stream flow conducted by the survey, Fahrenheit temperatures were measured by mercury-in-glass thermometers, altitude was estimated by an aneroid barometer, and the salinity of the water was determined by the usual silver-nitrate test.

The second of the two major investigations, that of discovering sub-surface waters by boring, was greatly facilitated by Mr. Blake's report (previously mentioned) on the Geology and Hydrology of Transjordan, in which he had recommended likely sites for drilling. Prior to the Hydrographic Survey, indeed, six wells, of which three had struck water, had been sunk by the Government in the Transjordan Plateau; while records were available from other recent wells drilled by engineers of the Hejaz Railway, the Iraq Petroleum Company and the Syrian Government, just beyond the Transjordan frontier. By the end of August, 1938, when work was stopped by political disturbances in Palestine, 18 further wells had been drilled by engineering contractors to the Department of Development of the Transjordan Government. These borings were carried out on the Jordan Valley terraces near the Wadi Shaeb, near Ghor El Kibid to the east of the Jordan north of the Dead Sea, and in the region around Maan.

The results of earlier drilling in the Plateau and the evidence of other records collected by the Government Geologist offered little hope that water would be found in this last region at a high enough level and in sufficient quantities to be of economic use, save possibly near Shera, to the west of Maan, where a high water table leading to a large number of seepages was known to exist. The main object in drilling there was, consequently, to discover whether tube wells would enable useful quantities of water to be extracted. The drillings started with 16-in. or 12½-in. casing, and finished with 8½-in. casing, baling and pumping tests being made as soon as good yielding conditions were attained. Observations were made concurrently of the water and soil analyses. As each well was completed, arrangements were made for the water level to be periodically noted with reference to a fixed datum, the well being meanwhile fitted with a protective cap to prevent damage.

In four cases out of 18 wells for which details are presented in the report, no water was struck, although economic depths were attained, and, in at least one instance, surpassed, where a well at Irbid was sunk through rock and shale strata to a depth of 575 ft. The yield of the successful wells varied between wide limits, from 1 cub. m. to 20 cub. m. per hour, the water being usually of good, sweet quality, and only rarely so brackish as to be quite unsuitable for irrigation purposes. Seldom, however, were a large yield and a high water level discovered in combination, with the consequence that pumping from wells is unlikely, in general, to prove an economically feasible source of irrigation water. Of the old-established wells with good yields, some are already fitted with steam or windmill-driven pumps and serve outlying stations of the Royal Air Force, the Railway and the Petroleum Company. For such domestic purposes, pumping costs can be justified. Over the greater part of the Plateau, however, where the water horizons are drained to low levels by the main Rift Valley and the deeply eroded wadis leading to it, the conclusion of the survey is that no important quantities of water can be pumped. Farther north, on the eastward slopes of the Jordan Valley, sub-surface water is more plentiful, but it is here particularly that such water is either evaporated or transpired by the vegetation, or seeps through alluvial deposits which were laid down under the sea, imparting progressively increasing salinity to water seeping westward through the Jordan terraces. Nevertheless, in two areas that have been explored in this region, water exists in sufficient quantities near the ground surface to make its exploitation a possibility worth considering.

The potential water supplies of Transjordan are compactly summarised in the subjoined table.

Source.	Quantity. Millions of Cub. M. Per Annum.
Rainfall supply to Transjordan Basin ..	4,472
Ground-water flow derived from Transjordan Basin	282
Direct run-off from Transjordan Basin	299
Flow of River Yarmuk—	
Ground-water	254
Direct run-off	226
Total from River Yarmuk	480
Flow of River Jordan at outlet from Lake Tiberias	540

It should be noted that some of the flow in the Jordan and Yarmuk rivers comes from rain and other more immediate sources in the higher reaches of these valley basins which lie outside Transjordan territory. The values tabulated above represent the quantities of water actually present, not necessarily those that can be used. Thus, the rainfall is measured over the gross area of the basin and includes all rain which, falling and remaining on uncultivable land, cannot be recovered. The direct run-off, moreover, probably includes, like the ground water, much water that could not be used without elaborate and prohibitively expensive works. The report contains details of these sum-

marised measurements, grouped under three main districts, namely, the Jordan and Yarmuk rivers, the streams flowing from the Transjordan hills into the Rift Valley, and the streams and springs in the hills. Not all of these details were recorded by the Hydrographic Survey during the short time at its disposal. In particular, the flow measurements of the Jordan and Yarmuk, collected over a number of years, are due to the Department of Development of the Palestine Government and to the Palestine Electric Corporation.

The major conclusions presented in the report, respecting the extent to which the water resources of Transjordan can be economically developed, and the manner in which such development should be attempted, are based on the experience that a rainfall of 200 mm. (8 in.) per annum is the minimum with which dry farming, without irrigation, is possible. The area over which this minimum is exceeded is estimated at 3,500 sq. miles—about one-tenth of the total area of Transjordan—but only about half of it is cultivable, the rest being denuded hillside, rocky outcrop, forest or scrub. In the east, where there are great expanses of deep, open soil, the rainfall is tantalisingly deficient; whereas, near the edge of the plateau, where the rainfall increases, soil is the scarcity. The land becomes a succession of hills and valleys passing to sharp ridges and deeply incised drainages, and eventually to precipitous slopes and sheer gorges, giving on to the Rift Valley. Thus the cultivable area, having an average rainfall of 14 in., amounts to no more than 1,750 sq. miles, of which about 100 are at present irrigated, the remainder being dry-farmed, with an annual rainfall between 8 in. and 12 in. over 700 sq. miles. Another 700 sq. miles receives over 20 in. of rain, but owing to soil denudation, ground slope and other causes, only half of it is cultivable. In Palestine, by comparison, the cultivable area is four times that of Transjordan and its average rainfall is 21 in.

The irrigated area of Transjordan lies mostly within the Ghor lands adjoining the Jordan, and is included in the cultivable zone. The irrigation water, drawn from perennial streams and springs, is estimated at 8,500 million cub. ft. per annum, allowance being made for transmission losses before the water reaches the fields. Practically all of it is already used for irrigation, but the systems in which it is distributed are wasteful, due to lack of organised control, and are not well adapted for progressive development. In the view expressed by the report, equable and regular distribution according to a permanent arrangement are essential, since only by such control can the landowners feel justified in spending money on improvements.

Outside the irrigable areas development offers little promise of supporting any significant increase of population. The paucity of rainfall over the dry-farmed areas, indeed, sets a limit for self-supporting permanent settlement that has probably been exceeded already, and the present inhabitants are barely able to subsist at the improved standard of living to which the opening-up of the country, since the Mandate, has introduced them. Technical progress is, of course, possible, in the improvement of the present primitive methods of agriculture and in the quality of the produce. Peaceful conditions in the desert to which the east flank of the whole cultivable belt is exposed, with an accompanying security of tenure for landholders, have already stimulated a degree of progress which may continue, but the fruits of such advance will be absorbed by the numerical increase and rising standard of living of the existing population.

One other aspect affecting the development of the dry-farmed areas is the prevention, and to some extent the reclamation, of land denuded by erosion. The past effects of soil erosion have been disastrous, and, while there is evidence at the present time of a stable condition of balance between the rate of erosion by run-off water and the formation of new soil by geological and geophysical processes, deliberate soil conservation is of supreme importance if the productivity of the dry-farmed land is to be increased. It must be combined with measures for the protection of the regenerated land by terraces and possibly by forest belts disposed so as to exert the greatest protection of land lying in their lee. It can be accomplished, asserts the report, but only gradually and by something like a nationally organised, concerted effort on the part of the farmers themselves, since Transjordan has no financial resources to devote to unremunerative works of that kind.

The only sphere of development that can surely, quickly and profitably contribute to the increased production, of which Transjordan stands in need, is irrigation. The perennial flow gained from springs in the hills, estimated at nearly 3,000 million cub. ft., is already practically all used for irrigation; but this aggregate supply is derived from hundreds of springs, mostly small and owned by distinct villages, and their situation in narrow valleys is conducive to distribution without serious dispute. A most useful function that the Government could perform in these circumstances, would be to augment the water supply to the fields requiring it by building impervious canals, but under all but exceptional conditions such developments would be unlikely to pay until markets are better than they are at present.

Equally unpromising, according to the analyses in the report, is the possibility of conserving direct run-off for irrigation. It is only the direct run-off from the desert, to the east of the dry-farmed zone, storage of which could be considered legitimate. The survey has shown that the effective supply that could be derived from the storage of flood water, intervening between periods of drought, would support no more than 1,000 persons. It would cost, including interest charges, not less than 20*l.* a head, which is three or four times the present average income of the nomadic population. Even though individual cultivators were prepared to store run-off water by their own efforts at their own cost, the aggregate benefit could be of only very minor importance.

Of the alternative schemes advocated in the Survey Report, the control and regulation, by the Government, of the perennial streams in the Ghor is regarded as a most profitable investment; even though the necessary construction of works and other matters incidental to the assumption of Government control would take several years to complete. An annual sum to cover the cost would accrue from increased land taxation, and would justify this most needed form of water conservation being undertaken.

From the technical standpoint, more interest attaches to the possibilities of a high-level canal, taking water from the River Yarmuk and providing irrigation for 16 square miles of land between the Yarmuk and the Wadi Zerqa. Included in this area is the Wadi el Arab and its tributaries. The estimated costs for this scheme—£P.70,000 for capital outlay and £P.5,500 for annual maintenance, including interest on capital—are considered to offer no difficulty, even under the present standard and system of irrigation farming in the Jordan Valley. The estimated take-off totals 90 cusecs, allocated as 62 cusecs from the Yarmuk, 18 cusecs from the el Arab, and 10 cusecs from the Zerqa. If account be taken of transit losses, the annual supply available for irrigation amounts to just over 1,000 million cub. ft., providing an allowance of 100,000 cub. ft. per acre, the equivalent (numerically) of 23 in. of rain. Further than this broad outline, the proposed Yarmuk Canal Scheme cannot be formulated at present because the Palestine Electric Corporation has rights to water from the Yarmuk. Such water, however, would provide a supply of new, free-flow water in Transjordan.

The report discusses the merits of saving seepage losses by making concrete channels, and observes that the cost of this form of development is so high by comparison with that of providing additional sources by the Yarmuk Canal or by widespread control of present sources, as to make it a far less profitable national investment. The possible saving by staunching existing canals is about one-third of the total discharge from the perennial springs and streams, *i.e.*, some 1,800 million cub. ft. per annum, but its estimated cost is about four times that of the Yarmuk scheme.

The possibilities of low-lift pumping from the Jordan are limited by the available area of suitable land. Much of the suitably situated territory is liable to flooding, and is covered with reeds, scrub or forest which are costly to clear. In the more favourably situated places there should be economic possibilities, and already an area of about 1,000 acres is supplied by four established pumping plants. Larger areas are available for high-lift pumping to the Ghor territory, but the lift is high, water must be piped for long distances, and irrigation costs are correspondingly heavy. Pumping from wells is equally expensive, and on a large scale would cost about ten times as much as the Yarmuk Canal scheme, per unit of irrigation water delivered. This is an average figure. There are places, for example, the Ghor el Kibid, where the water table being high, and the yield and quality of the water very good, a lower cost might be expected. The total supplies from wells throughout the Ghor cannot, however, be assessed at more than about 900 million cub. ft. per annum.

In general, states the report, high-lift pumping from the Jordan and from tube wells can scarcely be considered nationally profitable so long as a chance can be offered for investors to acquire secure rights in the systems where free-flow water from the hills is still used for extensive farming. The individual may, in exceptional circumstances, profitably invest in a well, but substantial development in this direction is unlikely. Indeed, a tendency towards such development might be regarded as a sign that closer control of free-flow supplies is needed. Private enterprise might prove profitable, too, in low-lift pumping, for areas where the land is reasonably sweet and clear of scrub, and favourably situated with respect to markets.

To summarise these conclusions, therefore, it may be said that, while progress in dry-farming and irrigation in the hills are among the pressing needs of Transjordan, gradual development by individual enterprise is essential in so far as such development depends upon the conservation of water. No capital can be profitably expended by the Government, as yet, on conservation works, but Governmental encouragement and effort may be directed, with advantage, towards stimulating individual enterprise by land settlement and education.

In the Jordan Valley, by contrast with the hill country, opportunities for Government assistance towards agriculture depending upon irrigation arise from the need for water distribution and control upon a large scale. The control of existing irrigation systems in the Ghor, and the construction of the suggested Yarmuk Canal, both appear to be profitable and practicable possibilities. Together, they would secure 5,000 million cub. ft. of irrigation water annually, in a region where crops of cereals, citrus fruits and bananas can be grown. The total capital expenditure on the two schemes is estimated at £P.120,000, which is sufficient to occupy several years of development. If and when these works are completed, a programme of canal staunching or reconstruction, to recover water at present being lost by absorption in the earthen canals of existing irrigation systems, offers the next cheapest form of investment. It is impossible to foresee at present whether any profit from this development can accrue if it is widely applied, but there are certain known districts which are placed sufficiently favourably for recovery to be well justified economically. Irrigation by pumping holds no prospect of profit except under expert management in rare, specially favourable situations, and the chances of large developments in this sphere in the near future are small.

THE NEW YORK AIR BRAKE COMPANY.—We have received from Messrs. The New York Air Brake Company, 420, Lexington-avenue, New York, an interesting historical brochure issued to mark the 50th anniversary of its incorporation. The company was formed in 1890 to take over the assets of the Eames Vacuum Brake Company, which had been founded in 1876 at Watertown, New York, to manufacture the brake invented by Frederick W. Eames. We note that there are three members of the staff—Mr. Charles E. Leach (secretary and treasurer of the company), Mr. Charles Lovell, and Mr. William H. Lyon—who joined the organisation when it was still the Eames Vacuum Brake Company. The brochure includes a brief history of the use of vacuum brakes on American railroads.

SYNTHETIC-RESIN CEMENTS FOR WOOD.

MESSRS. BRITISH INDUSTRIAL PLASTICS, LIMITED, LONDON.

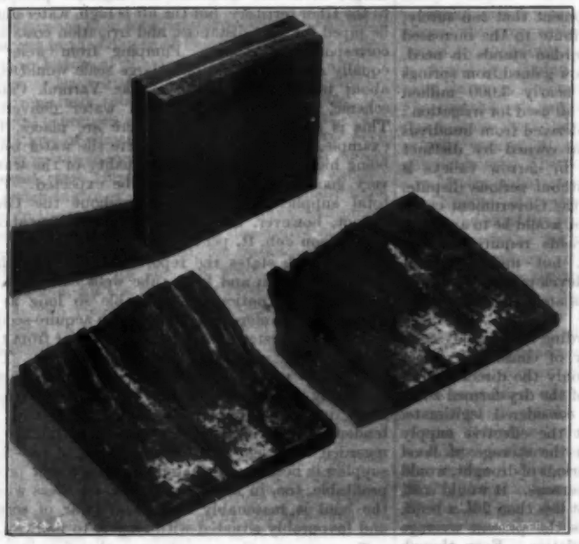


FIG. 1. FAILURE OF JOINT THROUGH FRACTURE OF WOOD.

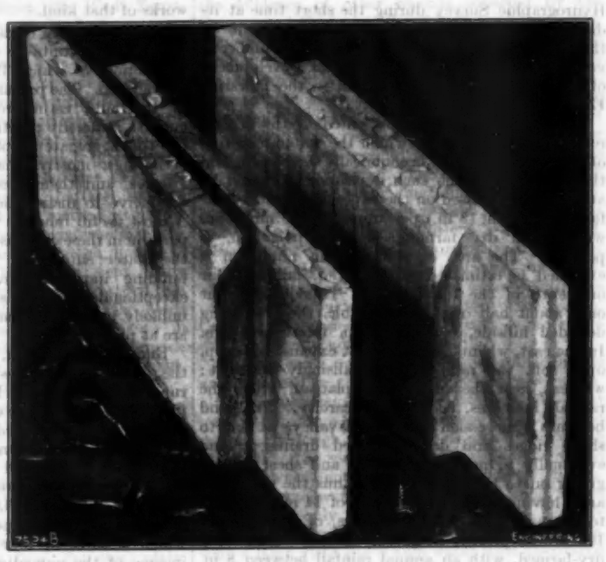


FIG. 2. CASEIN AND CEMENT JOINTS AFTER IMMERSION.

SYNTHETIC-RESIN CEMENTS FOR WOOD.

FROM being a material of importance only to the carpenter, joiner and cabinet-maker, glue, or rather the later forms of adhesive replacing it, has become one of the materials of the engineer. As an example, we may mention that in ENGINEERING, vol. 140, page 358 (1935), there was an illustrated account of the processes of the manufacture of cylindrical plywood barrels or drums, which in many instances have displaced both the old coopered barrel and the heavier metal drum. Certain of the plywood barrels described have to withstand internal pressure due to the expansion of their liquid contents from fermentation or mild heat, and a cardinal feature of the successful development of such barrels was the adhesive used between the layers of wood. This had to be waterproof and resistant to the attacks of insects, bacteria, mould, fungus, etc., and also had to be colourless and scentless, so that foodstuffs should not be contaminated, as well as capable of withstanding acids. These requirements, it was stated, were met by the employment of new glues, the trade names of two of which were Kaurit and Tego. Another example of the use of adhesives for wood in engineering products is in the manufacture of some types of aircraft, the importance of this application and others for war purposes being indicated by the appointment, under the Timber Control, of a Controller for the Production of Technical Plywood.

The article referred to above dealt with plywood barrel manufacture as practised in Germany, the adhesive mentioned in it, viz., Kaurit, being made by I.G. Farbenindustrie Aktiengesellschaft. In 1936, the German firm arranged with Messrs. British Industrial Plastics, Limited, 1, Argyll-street, London, W.1, to make Kaurit Glue W in England and sell it under that trade name. The necessary details of manufacture were supplied and since 1937 all Kaurit Glue W sold in this country has been made here. This being so, there seemed to be little point in retaining the original name, and Messrs. British Industrial Plastics have accordingly renamed the product "Beetle Cement W." After considerable research, the firm developed a second product, known as "Beetle Cement A," which meets certain requirements that the original formula did not fulfil. Still more recently a third cement, in powder form and known as "Beetle Cement H," has been introduced. Some notes on all three are given below and are illustrated by Figs. 1 to 3 on this page.

All three Beetle cements are of the synthetic-resin type, having urea-formaldehyde compounds as a base, being thus not unlike some of the well-known moulded plastics as regards composition. The ordinary glues made from hides, hoofs, and so forth, the fish glues and the rubber-base marine glues all make a bond by the physical changes which take place in them as they dry, no change in composition occurring. The synthetic-resin glues or cements, on the other hand, form a bond owing to the physical changes following chemical reactions which take place as the drying proceeds. The original Kaurit glue was chiefly used in processes requiring both heat and pressure, a technique which resulted in rapid setting and was thus well suited to such production methods as are involved in the manufacture of the plywood barrels already alluded to. The setting times varied, in this particular application, from 2 minutes to 2½ minutes, the temperature required from 266 deg. F. to 311 deg. F., and the pressure from 85 lb. to 215 lb. per square inch, the differences being due to the various types of barrel produced. The several layers of plywood were coated with the glue independently on the contacting surfaces, and this was allowed to dry. The sheets thus prepared were wound round a heated drum, the first contact with which melted the glue and caused the layers to adhere. Continued exposure to heat under pressure caused the softened glue to harden and set firmly. It may be noted here that the temperatures cited above are exceptional and peculiar to the process involved. More normal temperatures range from 200 deg. F. to 210 deg. F. For flat sheets a similar result was obtained by treating them in an hydraulic press having heated platens. The glue could also be used when cold setting was required, though this is a slower process, considerable pressure being needed and the contacting surfaces having to be machined smooth.

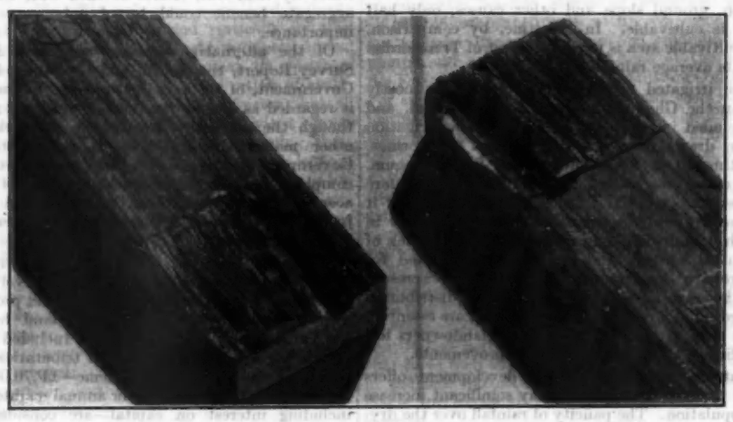


FIG. 3. SHEAR TEST ON WALNUT SPECIMENS.

The demand for a cold-setting cement, and, moreover one that does not need great pressure, has increased during recent years, since constructions in which neither heat nor pressure can be applied are becoming more important, examples of such constructions being found in aircraft manufacture. It was to meet this demand that "Beetle Cement A" was developed. The cement, which is a liquid and is always used with a hardening compound, amounting to about 6·25 per cent., by weight, of the cement, can be employed to bond roughly finished surfaces, since its strength is such that it may be employed in a layer of up to 0·02 in. in thickness. For test purposes even thicker layers can be used. The results of such a test are shown in Fig. 1.

In this, two pieces of walnut, with an area of approximately 9 in. by 5 in., were cemented together cold, the thickness of the cement layer being between 0·03 in. and 0·04 in. The thickness was determined by the insertion of metal distance-strips between the two pieces of wood, and an ordinary building brick was placed on the top piece. Its weight was naturally taken by the metal strips, the pressure on the cement itself being, therefore, virtually negligible. When the cement was set, the block was sawn into squares, as shown at the top of the illustration. A steel wedge driven into the cement layer resulted in the wood itself being torn through over a large part of the area, as will be evident from the separated halves seen in the foreground. In the parts of the cement exposed in this way there was no evidence of "crazing" from contraction.

As regards strength in shear, typical tests on specimens with a cement layer 0·2 in. thick made 72 hours after cementing gave an average rupturing load of 1,409 lb. per square inch, some of the specimens failing through the wood and others through the cement, though the

"ZEELOCK" INSERTED-BLADE MILLING CUTTERS.

MESSRS. THOS. FIRTH AND JOHN BROWN, LIMITED, SHEFFIELD.

FIG. 1. STAGGERED-BLADE SIDE AND FACE CUTTER.

FIG. 2. END-MILLING CUTTER.

fractured surfaces in the latter case showed numerous fibres of wood torn away. Specimens tested wet after immersion for 24 hours in water, gave an average rupturing load of 1,675 lb. per square inch. These tests were made with walnut pieces to comply with the requirements of Air Ministry Specification D.T.D. 335, the joint being a single lap. The result of a typical shear test with "Beetle Cement W" is illustrated in Fig. 3. Here again the wood, which is American black walnut, has failed, the cement still holding. The tests showed that specimens break through failure of the wood at loads ranging from 1,100 lb. to 1,500 lb. per square inch. It may be noted that the Department of Scientific and Industrial Research in its *Handbook of Empire Timbers*, 1939, gives the maximum shearing strength, parallel to the grain, of American black walnut as 1,220 lb. per square inch for green timber and as 1,370 lb. per square inch for air-dried timber with a moisture content of 12 per cent. It may be considered, therefore, that the cement is of ample strength for this class of wood.

The tests referred to above are for normal temperatures, but tests of Beetle Cement A joints under conditions of abnormal cold have also been made. Single-lap joint walnut specimens were immersed in solid carbon-dioxide in a refrigerating chamber for 24 hours, and then quickly removed and tested for shear strength. Failure, of the two types already discussed, took place with an average load of 1,239 lb. per square inch, with a thin layer of the glue, while with a layer 0·02 in. thick the average rupturing load was 1,218 lb. per square inch. So far, tests of strength only have been discussed, data on durability being naturally scanty in view of the recent development of the cements. It is stated, however, that specimens prepared for shear testing have been found after some nine months storage in the laboratories to give as good results as more freshly-prepared specimens. Neither is it practicable to give details regarding the precise effects of the various types of hardener which are always mixed with the cement. Briefly, it may be said that different hardeners are used to give different setting times, to render the cement mixture usable over longer periods, for waterproofing against cold or warm water, or to render it resistant to boiling water.

The ordinary hardeners used with either the "A" or "W" cements have proved to be resistant to cold water by remaining unaltered after several years exposure to the weather and are satisfactory for use in temperate climates. An example of an immersion test for several weeks is shown in Fig. 2. The sample on the left is a specimen bonded with casein glue, an organic substance derived from milk. That on the right is a typical Beetle Cement joint and shows no sign of deterioration. For tropical climates a special hardener is required and another is necessary for plywood which is required to be resistant to boiling water. The hardener used to comply with a particular Air Ministry Specification, for example, gives the following results from shear tests: The average rupturing load of 343 lb. per square inch which results from wood failure is only lowered to 275 lb. per square inch on testing the specimen wet after being boiled continuously for 3 hours, failure then occurring in the glue with adherent wood fibres. The specimens in this case were three-ply birchwood veneer, 1¼ mm. thick. The specification, incidentally, laid down minimum loads of 200 lb. and 100 lb. per square inch, respectively, for such tests. The setting times of the cements vary with the method of application adopted. With "W" cement hot pressed at a temperature of between 194 deg. F. and 212 deg. F., and a pressure of about 30 lb. per square inch, the setting is complete in 5 minutes to 8 minutes, with plywood of normal thickness. With cold pressing at 60 deg. F., the setting time is 30 minutes. With cement "A," and only sufficient pressure to keep the parts in place, the setting time may vary from 6 hours to 24 hours at 60 deg. F.

Both cements "A" and "W" are in liquid form and if stored for more than, say, three months, are apt to become difficult to spread, owing to an increase in viscosity. This limits their use under present day conditions for export. Endeavours have, therefore, been made to produce a cement in powder form, some approach to this handy type having been made in Germany some two or three years ago. Messrs. British Industrial Plastics, however, attacked the problem independently and in the "Beetle Cement H" have produced a synthetic resin glue which possesses all the properties of the "W" cement and only requires to be mixed with water, with the addition of an appropriate hardener, to replace this cement satisfactorily. The mixed glue, moreover, will remain in a condition suitable for use for a month at least, while the dry powder may be kept for over a year provided that the storage temperature is not allowed to exceed 80 deg. F. It should be a source of satisfaction to users of plywood that there will be no further need to import adhesives, since wholly British products are now available.

OUTPUT OF STEEL IN THE UNITED STATES.—The production of steel in the United States during the fourth week of January is estimated to have been 1,567,100 net tons, compared with 1,557,400 tons in the preceding week. It is stated that for the fourth consecutive week the first-named total constituted a high record of production.

LOCKED INSERTED-BLADE MILLING CUTTERS.

WHILE the advantages of the inserted-blade milling cutter, particularly for large sizes and heavy duties, are now generally recognised, the fixing of the blades presents some problems, judging by the numerous methods of effecting it that have been put forward from time to time. The method illustrated in Figs. 1 and 2, above, would seem, however, to provide a completely satisfactory solution of the difficulty. It has been developed by Messrs. Thos. Firth and John Brown, Limited, Atlas and Norfolk Works, Sheffield, 1, and the cutters thus fitted are known as Firth-Brown Zeelock milling cutters, the distinctive term being derived from the fact that the inserted blades are held in position by a "Z"-shaped wedge, which locks it solidly in the cutter body. This characteristic feature of the lock is not, perhaps, readily recognisable in the illustrations, but a second one, viz., that one face of the blade and its matching surface in the body are serrated, is clearly discernible, being particularly marked in Fig. 1, which shows a staggered blade side and face cutter, such as is used for slotting, channelling and keyway-cutting operations. Fig. 2 shows the application of the wedges to an inserted-blade end-milling cutter for surfacing.

It will be clear from Fig. 1 that the wedge lies in the slot of the body in contact with the front face of the blade, the term "front" being here used to indicate that bounded by the peripheral and one lateral cutting edges. The back face of the blade is serrated. It is not possible to see both of the arms of the "Z" of the wedge in the illustration, but, taking the four blades in the top left-hand quadrant, these arms are seen alternately. Thus in the blade virtually in line with the centre hole of the cutter, the arm embracing the non-cutting side of the blades is easily distinguished, as is also that of the blade next but one above it. Conversely, on the other two blades of this quadrant the other arm is seen as butting against a shoulder in the body recesses. This arrangement effectually prevents any lateral movement of the blades, which, in this particular cutter, make two side cuts as well as a bottom cut. The face of the wedge in contact with the front face of the blade is slightly inclined, while the non-cutting edge of the blade and the arm of the wedge in contact with it are also inclined. These face and edge planes thus lie at right angles. As the peripheral edge wears and regrinding is necessary, the blades have to be moved radially outwards, this being effected evenly all round by altering their position by one serration, the edge being, of course, loosened to enable this to be done. Since, however, one lateral edge of the

blade is also subject to wear, the blade must be moved sideways as well as radially outwards.

This lateral movement accompanies the outward adjusting movement, due to the inclination of the non-cutting edge of the blade and that of the embracing arm of the wedge. Apart from the function of the serrations on the back of the blades in enabling a uniform cutting diameter to be obtained without the aid of any setting device, they absorb the thrust of the peripheral cut, and increase the area of frictional contact. The wedge acts only as a locking member and is not affected by the cutting thrust. The cutter body, moreover, is of a tough alloy steel and although its periphery is slotted to take the blades, the strength is adequate to resist deformation. The blades are readily released for adjustment by using a drift in the slot under the wedge, thus starting it radially outwards. Conversely, the wedges are inserted radially and driven home in the same direction. The details of the Zeelock cutters are the same in the end-mill shown in Fig. 2, as those already described, though there is only one cutting face in use. The arm of the "Z" engaging with the cutter body is quite distinct in the illustration, and it is possible to distinguish that engaging with the non-cutting edges of the blade in some cases. The blades are interchangeable in different sizes of cutters of the same style, and for general purposes are set at 10 deg. undercut and 10 deg. helix angle, other angles being available for particular requirements.

For certain cutters, such as interlocking side and face cutters, and plain side and face cutters in which all the teeth cut on both sides, and are not staggered, the serrated blade is retained, but the wedge is modified. The blades shown in Figs. 1 and 2 are of Speedicut high-speed steel, hardened and ground, but if the production methods adopted justify the extra expense, high-tensile steel blades tipped with Firth-Brown carbide may be used, these being interchangeable with the standard Zeelock cutter blades.

INSTITUTION ELECTIONS.

INSTITUTION OF MECHANICAL ENGINEERS:

Member.—Herbert George Woodhouse Taylor, B.A. (*Cantab.*), Crayford, Kent.

Associate Member to Member.—Cyril Gordon Crawford, Barbados, B.W.I.; Harold Page Haslam, Birmingham; Commander (E.) Henry William Head, R.N., London; Colonel Dougal Campbell McPherson, M.B.E., Bristol; Frank Seymour Sweet, Birmingham; Leonard Copeland Watts, London; Charles Garrett Williams, M.Sc. (*Manch.*), B.Sc. (Eng.) (*Lond.*), Chester.

Associate Member.—William Henry Allen, Karachi, India; James Archibald Barr, Glasgow; David Beavis, Helensburgh, Dumbartonshire; Sidney Chisholm Bullen, Manchester; Lieutenant (E.) Arthur James Cawthra, R.N., Birkenhead; Harold Hockenhull Clayton, Talana, Natal; Frederick Charles Clemo, Hong Kong; Eric Harry Leach Cooper, Rugby; Jack Brian Dimmock, London, W.C.2; Donald Frederick Galloway, B.Sc. (Eng.) (*Lond.*), Wh.Sc., London, W.1; Harry Harvey, Doncaster; Alexander William Hildrew, B.Sc. (Eng.) (*Lond.*), London, W.3; Clement Murray Kerr, London, S.E.1; William John Magowan, Glasgow; Ronald Arthur Dexter Main, Liverpool; Alfred Marriner, London, S.W.18; Captain Duncan Angus Matheson, R.E., Belfast; Major Harold Ernest Milburn, R.A.S.C., Bournemouth; Thomas Oswald Miller, Glasgow; Ernest William Molloy, Ruislip, Middx.; Lieutenant Frederick Radford, R.E., Cambridge; Frederick James Sanger, M.Sc. (Eng.) (*Lond.*), Shanghai, China; William Sephton, Chester; George Benjamin Tyler, London, E.C.2.

Associate to Associate Member.—Archibald Stanley Cowlishaw, Buenos Aires.

Graduate to Associate Member.—Frederick Arthur Atherton, Runcorn; William Turner Baird, Bath; Captain Gabriel Priestman Clay, B.A. (*Cantab.*), R.A.O.C., London; Howard Jackson Coates, West Hartlepool; Hugh Graham Conway, M.A. (*Cantab.*), Warrington; Alfred Farnsworth, Chesterfield; Albert Henry Flower, Southall, Middx.; John Thorburn Hillhouse, Irvine, Ayrshire; William Hughes-Jones, Newcastle-upon-Tyne; Roy Jagger, Swansea; Flying Officer, Phil Prince Love, B.Sc. (*Glas.*), R.A.F.V.R., Lochwinnoch, Renfrewshire; Thomas O'Beirne, Glasgow; Lieutenant Charles Harry Broughton Pipkin, R.A.O.C., Bromley; Lieutenant Neil Curtis Purdie, R.A.O.C., Sheffield; Joseph Raymond Snow, Loughborough.

IMPORTS OF MOTOR-CAR TYRES INTO EIRE.—The Government of Eire has issued an Order which fixes the quota, for the period April 1 to September 30, for the importation of certain motor-car tyre inner tubes and outer covers into that country. The quantities involved are 2,000 inner tubes and 2,000 outer covers.

ANNUALS AND REFERENCE BOOKS.

The Mining Year Book.—The fifty-fifth annual edition, that for 1941, of this well-known annual work of reference has recently been published. It contains particulars concerning 975 companies engaged in the mining of gold, silver, copper, tin, lead, zinc, diamonds and other minerals and metals in all parts of the world. Information on exploration and mining finance companies is also included. The particulars given for each company comprise the names of the directors and principal officials, the date of establishment, the seat of operations, a brief description of the property and of the plant erected or in course of erection, the present working results, an indication of ore reserves, and financial data. Lists of the names and addresses of directors, mining engineers and mine managers, and of the names of the companies with which they are connected, are also given. Other useful sections are a glossary of mining and other terms, and statistical tables showing the monthly and annual production of gold in various parts of the world, and the highest and lowest prices of copper, tin, lead, zinc and silver, during the past eight years. Several folding sketch maps and plans, showing the position and extent of the property of various companies, are included. We understand that, in spite of the abnormal conditions met with during the compilation of the work, the data have been carefully revised in all cases. The book contains 860 pages, and, bound in the usual scarlet-cloth covers, its price is 20*s.* net, or, including postage, 20*s.* 6*d.* inland and 21*s.* 6*d.* abroad. It is obtainable from the compiler, Mr. Walter E. Skinner, 15, Dowgate-hill, Cannon-street, London, E.C.4, or from the *Financial Times*, 72, Coleman-street, London, E.C.2.

BOOKS RECEIVED.

Introduction to Works Practice. A Practical Guide to Procedure in Engineering Production; How to Read Blueprints. Micrometers, etc., and How to Make Workshop Calculations. Prepared under the Direction of E. MOLLOY. London: George Newnes, Limited, Tower House, Southampton-street, Strand, W.C.2. [Price 5*s.* net.]

United States National Bureau of Standards. Building Materials and Structures. Report BMS 61. *Structural Properties of Two Nonreinforced Monolithic Concrete Wall Constructions.* By H. L. WHITTEMORE, A. H. STANG and D. E. PARSONS. Washington: Superintendent of Documents. [Price 10 cents.]

British Cast Iron Research Association. Special Publication No. 7. *The Sampling and Chemical Analysis of Cast Ferrous Metals.* Third edition, revised and enlarged. By E. T. AUSTIN. March, 1941. 21-23, St. Paul's-square, Birmingham, 3: Offices of the Association. [Price 15*s.* net.]

Commonwealth of Australia. Council for Scientific and Industrial Research. Bulletin No. 135. *Investigations on the Storage of Jonathan Apples Grown in Victoria.* By DR. S. A. TROUT, G. B. TINDALE and DR. F. E. HUELIN. 314, Albert-street, East Melbourne, Victoria: Offices of the Council.

Canning Practice and Control. Second edition, revised and enlarged. By OSMAN JONES and T. W. JONES. London: Chapman and Hall, Limited. [Price 32*s.* net.]

Department of Scientific and Industrial Research. Building Research. Wartime Building Bulletin No. 14. *Centreless Arch Designs.* London: H.M. Stationery Office. [Price 1*s.* net.]

India. Central Board of Irrigation. Publication No. 20. *Regime Flow in Incoherent Alluvium.* By GERALD LACEY. Simla: Central Board of Irrigation.

The British Corporation Register of Shipping and Aircraft. Register of Ships, 1941. Glasgow: Offices of the Corporation. [Price 4*l.* 4*s.* net.]

United States War Department. Miscellaneous Series No. 1. *Port and Terminal Charges at United States Seaports.* 1940 edition. Washington: Superintendent of Documents. [Price 1 dol.]

Practical Metal Turning for Engineers. By J. G. HORNER. Fourth edition, revised. By PHILIP GATES. London: The Technical Press, Limited.

CONTROL OF FABRICATION OF LIGHT METALS.—The Minister of Aircraft Production has made an Order, entitled the Light Metals and Alloys Fabrication (No. 1) Order, 1941, which came into force on February 25. The Order provides that no person may fabricate light alloys and light metals without a licence and that no licensed fabricator may dispose of his products except in accordance with the directions of the Minister. All inquiries should be addressed to the Ministry of Aircraft Production, Light Alloys and Magnesium Control, Southam-road, Banbury.

PERSONAL.

MR. FREDERICK CRESSWELL PYMAN, who has been a member of the board of the Iron Trades Employers' Insurance Association, Limited, for 17 years, has been appointed vice-chairman to fill the vacancy created by the death of MR. JOHN BARR, C.B.E.

MR. A. WINTER GRAY, O.B.E., is relinquishing the Secretaryship of the Institute of Transport on March 31. He will be succeeded, as acting Secretary, by MR. FRANK W. CREWS, B.A., the assistant secretary of the Institute. The retiring Secretary has been elected an honorary member of the Institute.

DR. JOHN JACOB FOX, C.B., O.B.E., the Government Chemist, has been re-elected President of the Institute of Chemistry for the session 1941-42.

The address of the ANGLO-ITALIAN, ANGLO-ROUMANIAN, ANGLO-SPANISH and ANGLO-TURKISH CLEARING OFFICES is now Alexandra House, Kingsway, London, W.C.2. (Telephone, TEMple Bar 3020.)

PROFESSOR E. L. E. WHEATCROFT, M.A., M.I.E.E., has resigned the professorship of electrical engineering in the University of Leeds to take up a position on the staff of Messrs. Merz and McLellan, consulting engineers.

MR. T. A. RIDELL, who has been with Messrs. Cope, Allman and Company, Limited, Unity Tube Works, Icknield-square, Birmingham, 16, for 54 years, and served as managing director for 24 years, has now retired from the board of directors.

MESSRS. METAL CONTAINERS, LIMITED, Moorpark Works, Renfrew, have transferred their London office from Horseferry House, Horseferry-road, to Seymour House, 18, Waterloo-place, Pall Mall, S.W.1.

MR. J. W. DAVIS, hitherto sales engineer in the North-Eastern area for Messrs. Benjamin Electric, Limited, Brantwood Works, London, N.17, has joined the staff, at Newcastle-upon-Tyne, of Messrs. British Thomson-Houston Company, Limited, Rugby.

The Minister of Transport has appointed MR. R. H. TOLERTON, C.B., C.B.E., D.S.O., M.C., to be Director of Ports. MR. S. S. WILSON has been appointed Deputy Director, and MR. R. P. BIDDLE, Assistant Director.

MR. C. F. DE PURY and MR. G. BISHOP have been appointed divisional superintendents, Southern Railway. The former is to take charge of the Southern Division and the latter is to control the Western Division.

NOTES FROM THE SOUTH-WEST.

CARDIFF, Wednesday.

The Welsh Coal Trade.—A good inquiry was again received from the overseas trades still open to local shippers on the Welsh steam-coal market during the past week. The market as a whole was very strong. Supplies of all grades, except some of the inferiors, were being steadily taken, and offers were consequently only very quietly made, especially for early delivery. Home demand was particularly brisk, and sellers were finding it difficult to meet consumers' requirements. With stem lists almost completely filled for a long time ahead, the odd lots that did become available were quickly taken up at high figures. Dry steams were being steadily taken by Eireann customers, who have been finding it increasingly difficult to secure their normal supplies of bituminous coal. The outputs of the best large grades were being steadily taken up under existing contracts, and a firm tone ruled. The sized kinds maintained a strong position and were almost completely disposed of for a long time to come. Bituminous smalls were very scarce, but dry steam smalls were dull. Cokes remained busy.

The Iron and Steel Trade.—Activities in the iron and steel and allied trades of South Wales and Monmouthshire were well maintained last week. The demand for the finished products was continued and most producers held sufficiently well filled order books to ensure the continuance of active conditions for some time.

PHOTO-ELECTRIC CONTROL OF BESSEMER STEEL-MAKING; ERRATUM.—By an unfortunate printer's error, Fig. 3, on page 238, *ante*, showing the infra-red and visible radiation of the Bessemer flame, has been printed upside down, thus rendering the references to it inaccurate. With this explanation, however, they should not be difficult to follow. We much regret the error and offer our apologies to Dr. H. K. Work, the author of the paper.

JUBILEE OF NEW YORK AIR BRAKE COMPANY.—Last year the New York Air Brake Company celebrated its jubilee. The Company was formed in 1890, to acquire the assets of the Eames Vacuum Brake Company, which had, itself, been formed by Mr. F. W. Eames in 1876. In order to mark the occasion, the Company has issued an illustrated brochure containing a history of its formation and subsequent progress, and a brief account of the manufacture and testing of railway-brake assemblies. Short biographies and portraits of some of the firm's oldest officials and employees are also included.

NOTES FROM SOUTH YORKSHIRE.

SHEFFIELD, Wednesday.

Iron and Steel.—Few branches are more actively employed than those engaged in the manufacture of equipment for iron and steel producers. Since the beginning of the war, iron and steel works have been operating at high pressure, and plant has had to withstand a considerable amount of wear and tear with few opportunities for overhaul. Consequently, renewals are now becoming necessary. In some cases, entirely new plant is being put down, and in many cases extensions are in progress. The raw and semi-finished steel branches are operating at full capacity. Both basic and acid materials are in strong demand. Supplies of scrap are reported to be ample to meet requirements and the great activity in the steel-producing sections is indicated by the large tonnage of scrap being consumed. Conditions are similar in the special-steel producing branches. The amount of electric melting plant now in service is at least double that of two years ago. Exports are considered to be satisfactory in view of the restricted character of foreign business. Among the materials in particularly strong demand is manganese steel for the manufacture of points and crossings, dredger parts, and machine parts. Stainless steel is also in exceptionally heavy request, and heat- and acid-resisting materials are also a progressive section. Makers of agricultural and tool steels report that outputs are increasing. Business is good in certain non-war products, such as grinding and crushing machinery, and excavators. Stone crushers are in demand by certain overseas markets, notably South Africa, Canada, and Egypt. More orders are circulating for iron-ore and coal-crushing machines, cement and concrete mixers, and mechanical excavators. Firms dealing in reconditioned machinery are able to dispose of supplies without difficulty. Boiler makers continue to be busy, while firms specialising in all types of electric equipment are operating at full capacity. Toolmakers are also very busy.

South Yorkshire Coal Trade.—Production has been well maintained, and stocks at colliery sidings and merchant depots are accumulating. The general demand is up to the recent standard. Industrial fuel is being sent from this area in larger quantities and the house-coal market is still active. Coke is in strong demand.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Scottish Steel Trade.—The activity in the Scottish steel trade continues unabated. Plates of all descriptions have been in great demand, and as the bulk of the current output is required for essential purposes, there is little available for other than orders of first priority. Shipbuilders are working at full capacity, so that the tonnage of plates used is very high. There is a very steady demand for boiler plates and the total production for the next few months is fully booked up. The demands for special steels is also heavy. In the black steel-sheet trade the bookings amount to a large tonnage of both black and galvanised varieties, and the output for several months ahead is required for Government purposes. The supply of raw materials is generally good, but an increase in the tonnage of steel scrap would be welcome. The following are the current quotations:—Boiler plates, 17*l.* 12*s.* 6*d.* per ton; ship plates, 16*l.* 3*s.* per ton; sections, 15*l.* 8*s.* per ton; medium plates, ¼ in. and thicker, rolled in sheet mills, 21*l.* 15*s.* per ton; black-steel sheets, No. 24 gauge, 22*l.* 15*s.* per ton; and galvanised corrugated sheets, No. 24 gauge, 26*l.* 2*s.* 6*d.* per ton, all for home delivery.

Malleable-Iron Trade.—The West of Scotland malleable-iron makers are experiencing a steady run at present, and have many orders on hand. The re-rollers of steel bars generally are well occupied, but some are able to accept a certain amount of business for early delivery. During recent months the supply of semies has been ample, and by running plant at full capacity most of the orders were overtaken. Although there are prospects of a fair amount of work being required in the near future, buyers can secure early delivery at the moment. The market prices are as follows:—Crown bars, 15*l.* 12*s.* 6*d.* per ton; No. 3 bars, 13*l.* 12*s.* 6*d.* per ton; No. 4 bars, 13*l.* 17*s.* 6*d.* per ton; and re-rolled steel bars, 17*l.* 15*s.* per ton, all for home delivery.

Scottish Pig-Iron Trade.—In the Scottish pig-iron trade, makers are still experiencing a strong demand. Practically every specification coming to hand is urgent, but makers are endeavouring to meet all their clients' requirements. Hematite and basic iron are being delivered regularly to the steel makers, who are pressing for supplies, but orders from users of foundry iron are not so numerous. The raw material position is satisfactory. The following are to-day's market quotations:—Hematite, 6*l.* 18*s.* 6*d.* per ton, and basic iron, 6*l.* 0*s.* 6*d.* per ton, both delivered at the steel works; foundry iron, No. 1, 6*l.* 5*s.* 6*d.* per ton, and No. 3, 6*l.* 3*s.* per ton, both on trucks at makers' yards.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

General Situation.—Considerable market activity quickly followed the issue of delivery allocations of iron and steel for the second quarter of the year. Licences for the supply of a good proportion of the prospective output to the end of June have been released, but although the supply of several commodities has increased appreciably there is little tonnage available for ordinary industrial purposes. The virtual elimination of civil business, however, has enabled closer attention to be given to the requirements of priority users of iron and steel.

Cleveland Iron Trade.—There is still no indication of a material improvement in the supply of Cleveland pig, the small output of which is confined to the occasional transfer of a basic furnace to the production of iron of qualities suitable for the requirements of North-East Coast foundries. Their needs, however, are well provided for by regular deliveries from elsewhere. For certain specified purposes, adequate parcels of iron continue to arrive from Scotland and other producing centres, but in most cases Midland brands of pig are being used. The fixed prices of Cleveland pig are based on No. 3 description at 128*s.*, delivered within the Tees-side zone.

Basic Iron.—The output of basic iron is maintained at a level that fully covers the requirements of the makers' own consuming plants but provides no tonnage for other purposes. The recognised nominal value is 120*s.* 6*d.*

Hematite.—The situation in the hematite branch of trade shows little change. Strict rationing of the limited make and import parcels of American iron are still essential to ensure regular delivery for urgent requirements, and licences for supplies can be obtained only for distribution among consumers producing material for which no other iron is suitable. There is, however, a possibility that the output will be increased and that an appreciably larger supply will be obtained from overseas. Most of the tonnage available is absorbed at works owned by hematite makers. Consumers entirely dependent on the market for supplies have virtually discontinued their efforts to place new orders, but are pressing for full deliveries against existing contracts. The stabilised quotations remain at the level of No. 1 grade of iron at 138*s.* 6*d.*, delivered to North of England areas.

Foreign Ore.—There is still some difficulty in obtaining hematite ores but imports of other ores from abroad have increased substantially and have provided consumers with ample supplies.

Blast-Furnace Coke.—Sellers of Durham blast-furnace coke have large holdings, but have extensive delivery obligations and are disinclined to accept further orders until they have reduced their commitments considerably. The fixed price of good medium qualities is 35*s.* 6*d.* f.o.r.

Manufactured Iron and Steel.—Re-rollers have good working stocks of iron and steel semies and are running their plants at full capacity. In the finished industries, the demand for constructional-engineering material is rather easier so that greater attention can be given to the unabated demand for shipbuilding requisites. Black and galvanised sheets are in great demand, and bars, plates, light sections and special alloy steels are taken up as soon as they become available. Railway material is also in considerable demand. Among the principal market quotations are:—Soft steel billets, 12*l.* 5*s.*; hard billets, 13*l.* 12*s.* 6*d.*; joists and sections, 15*l.* 8*s.*; heavy plates, 16*l.* 3*s.*; and heavy rails, 14*l.* 10*s.* 6*d.*

Scrap.—The supply of iron and steel scrap might be increased with advantage. Users of heavy steel are desirous of making extensive purchases and there is considerable pressure for full contract deliveries of all grades of scrap material.

CONFERENCE OF ENGINEERING STUDENTS.—The annual conference of engineering students in Great Britain is to take place, concurrently with the National Union of Students' Congress, at Cambridge, from April 2 to 6. The Engineering Committee of the Union has arranged an interesting programme. Colonel B. C. T. Freeland, assistant adjutant general in charge of the entry of young officers into the Royal Engineers, is to speak on "The Student Engineer and the War." Mr. F. C. Maxwell, secretary of the Student Industrial Committee, will speak on "What Industry Expects from the University or College-Trained Engineer." There will also be discussions on the various University and College courses, from which suggestions for future alterations will no doubt be forthcoming. In addition, the subject of vacation courses will be discussed. In all, there will be six two-hour engineering commissions. The Secretary of the N.U.S. Engineering Students' Committee is Mr. Nahum Ordman, 3, King's-parade, Cambridge.

NOTICES OF MEETINGS.

IT is requested that particulars for insertion in this column shall reach the Editor not later than Tuesday morning in the week preceding the date of the meeting.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.—To-night, 6 p.m., The Mining Institute, Newcastle-upon-Tyne, 1. "The Economics of the Design of Condenser Plant and Cooling Water Systems, applicable to Power Stations," by Mr. W. T. Bottomley.

INSTITUTION OF ELECTRICAL ENGINEERS.—*North Midland Students' Section:* Saturday, March 29, 3.15 p.m., The Hotel Metropole, King-street, Leeds. Ordinary Meeting. "Telephone Transmission Improvements," by Mr. A. C. Holmes. (Preceded by a luncheon at 2 p.m.) *Institution:* Thursday, April 3, 12.30 p.m., Savoy-place, Victoria-embankment, W.C.2. Ordinary Meeting for the transaction of formal business only.

INSTITUTION OF NAVAL ARCHITECTS.—Wednesday, April 2, 12.30 p.m., The Royal Society of Arts, John Adam-street, Adelphi, W.C.2. Annual General Meeting. Annual Report of the Council, Election of President and Council, and other formal business only.

INSTITUTE OF FUEL.—Thursday, April 3, 2.15 p.m., The Connaught Rooms, Great Queen-street, Kingsway, W.C.2. "How Far is the Approximate Analysis a Reliable Guide to Coal Behaviour," by Mr. J. G. Bennett. (Preceded by a luncheon at 12.45 p.m.)

INSTITUTION OF CHEMICAL ENGINEERS.—Friday, April 4, 11 a.m., The Connaught Rooms, Great Queen-street, Kingsway, W.C.2. Nineteenth Annual Corporate Meeting. (i) Annual Report of the Council and Election of Officers and Council. (ii) Presidential Address: "Some Post-War Problems," by F. Heron Rogers. 12.45 p.m., luncheon.

JUNIOR INSTITUTION OF ENGINEERS.—Friday, April 4, 6 p.m., 39, Victoria-street, S.W.1. Informal Meeting. "Some Historical Bronze Castings," by Mr. Robert Lowe.

REGISTRATION OF MOTOR VEHICLES.—A total of 3,498 new road motor vehicles were registered in this country in January, 1941, compared with 11,746 in January, 1940.

THE CONTROL OF SULPHURIC ACID.—The Treasury, has issued the Sulphuric Acid (Charges) (No. 1) Order 1941, which directs that a payment of 6*s.* 4*d.* per ton of sulphuric acid (70 per cent. basis) shall be made to the Ministry of Supply, or as he may direct, in respect of all acid produced in the United Kingdom. The sum obtained will be used to meet the increased cost of freights on imported raw materials, any abnormal costs of distribution of the acid, and other contingencies. The Order, together with Direction No. 2, under the Control of Sulphuric Acid (No. 2) Order, 1940, came into effect on March 10. Inquiries should be addressed to the Controller of Sulphuric Acid, Ministry of Supply, 19, Berkeley-square, Bristol, 8.

IMPORTATION OF CARBON BLACK AND RAW RUBBER.—The Board of Trade announces that the open general licence permitting the importation of carbon black, obtained from natural gas or acetylene, from any country has been revoked, as from March 13. Individual import licences, however, will not be required for consignments of carbon black of this type which can be shown to the satisfaction of the Commissioners of Customs and Excise to have been dispatched to the United Kingdom before March 13, and are imported into this country before May 13. Applications for import licences for carbon black should be addressed to the Import Licensing Department. As from March 13, the open general licence for raw rubber is amended to include crepe. The wording now reads:—"Rubber, raw, including crepe; rubber latex; raw gutta percha and balata; but not including reclaimed and waste rubber."

THE GRADING OF ANGULAR CHILLED-IRON GRIT.—As a result of experiments, carried out at the request of the Ministry of Supply, the Association of British Shot and Grit Manufacturers has decided to reduce the large number of varying grades or sizes of "metallic abrasives," used in shot-blast apparatus, to a maximum of six standard grades. These are calculated to give the most effective and uniform operational results. Moreover, the new system of grading will secure greater efficiency and economy in production. The new grading A corresponds to the old grading 8-10; B to 12-14; C to 16-20; D to 24-30; E to 40-50; and F to 60 and fines. Round shot will continue to be available, graded in the usual sizes. The Iron and Steel Control hopes that all users of metallic abrasives will co-operate in this matter in the national interest, and if they experience any difficulty in changing works procedure to meet these conditions, the services of experts in both shot and blast-plant manufacture will be available to assist them.

CONCRETE-AGGREGATE HANDLING PLANT; GUNTERSVILLE DAM.

(*For Description, see Page 241.*)

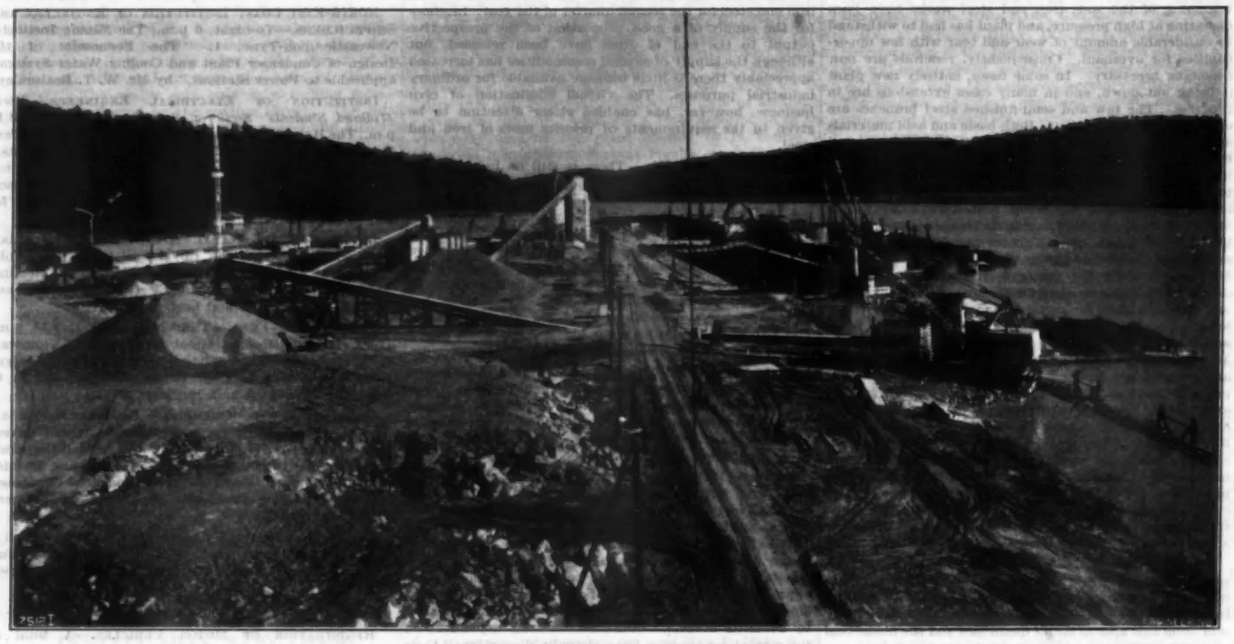


Fig. 9. General View of Plant.

Fig. 10. Aggregate-Storage and Reclaiming Plant.

The Williams Prize of the Iron and Steel Institute.—The Williams Prize, which has a value of 100*l.*, is open for award, subject to the discretion of the Council of the Iron and Steel Institute, to the author of a paper of a practical character adjudged by them to be the best paper of that type presented to the Institute and accepted for publication during any year. The only conditions laid down are that the author of the paper shall be a British subject regularly employed in a British iron or steel works, and that, at the time of presenting the paper, he shall be employed in such a works in a position not superior to that of manager of any one technical department. Papers need not be entered specifically in competition for this Prize; all those published by the Institute, which by their subject-matter and authorship fall within the terms of the award, are considered for the Prize. The first award of the Prize was made in 1927, jointly to Messrs. E. A. Atkins and C. S. Gill. The Prize was presented in each of the years 1928 to 1933, in 1937, and the last award was made to Mr. D. V. Krishna Rao in 1938.

CONCRETE-AGGREGATE HANDLING PLANT FOR CONSTRUCTION

(For Description, see page 24

Fig. 3. Stacker Tower Showing Boom and Flight A Conveyor.

Fig. 4. Flight B Conveyor and Stacker Boom

Fig. 6. Flight D Conveyor and Concrete-Mixing Plant.

Fig. 7. Flight E Conveyor Passing Under

RUCTION OF GUNTERSVILLE DAM, TENNESSEE VALLEY, U.S.A.

(See description, page 241.)

AND OTHER BOOM IN RECLAIMING POSITION.

FIG. 5. FLIGHT D CONVEYOR DELIVERING TO MIXING-PLANT TOWER.

YOR ING UNDER FERRY ROAD.

FIG. 8. DELIVERY END OF FLIGHT E CONVEYOR.

UNIV. OF MICH.

ENGINEERING.

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One Two-Page Plate.—CONCRETE-AGGREGATE HANDLING PLANT FOR CONSTRUCTION OF GUNTERSVILLE DAM, TENNESSEE VALLEY, U.S.A.

ENGINEERING

FRIDAY, MARCH 28, 1941.

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THE ST. LAWRENCE WATERWAY.

ON Wednesday, March 19, the United States and Canada signed an agreement which should ensure that the long-discussed Great Lakes and St. Lawrence river waterway and power project will be implemented at last. The importance of this brief statement will be appreciated by recalling that the St. Lawrence River system lies between the two countries, and for a distance of about 115 miles forms the frontier between them. The system itself may be regarded as consisting of two parts, namely, the Great Lakes, and the St. Lawrence River proper. The Great Lakes constitute the most extensive tract of fresh water in the world. Four of them, Lakes Superior, Michigan, Huron and Erie, are nearly at the same level, and are inter-connected by canals. The fifth, Lake Ontario, is at a considerably lower level than the others, but is joined to them by the Welland canal and by the Niagara River, in which lie the famous Falls. Above Montreal, the St. Lawrence is composed of alternate lakes and rapids, but canals have been constructed round most of the latter. Below the city, the river is narrow and without rapids as far as Quebec, where it gradually widens out to form the Gulf of St. Lawrence. On the shores of the Lakes lie a number of large cities, notably Buffalo, Cleveland, Detroit, Chicago and Milwaukee, in the United States, and Toronto in Canada. Several important ports on the Canadian side handle the wheat exported from the grain fields of the central and north-west parts of the Dominion.

The Great Lakes already carry many millions of tons of merchandise per annum, principally in the form of bulk cargoes such as iron ore, wheat and coal. If, therefore, such portions of these as are intended for overseas markets could be dealt with without transhipment, much time and money would be saved. True as this was in peace time, in war improvement has become, in President Roosevelt's words, "a vital necessity for defence," and is directly associated with the determination of the United States "to supply such aid in material to Great Britain, the members of the British Commonwealth and their Allies as may be necessary to bring the war to a successful conclusion." The other agreement made this week between the two countries, which will allow both nations, under certain conditions, to build naval and army vessels in the shipyards of the Great Lakes, will be assisted by the scheme. Its influence on post-war effort, also, may be profound, for it includes the erection of a number of hydro-electric generating stations. It has been estimated that, if necessary, some 6,943,000 h.p. could be developed in this way on a mean flow basis between Lake Ontario and Montreal. It is unfortunate, nevertheless, that a realisation of this part of the scheme should have been so long delayed by political considerations, especially as agreement has nearly been reached on more than one occasion. We could have made good use now of the power, which, as it is, will only be available in the future.

The project was first considered in 1920, when a report was prepared by the engineers of the Governments of Canada and the United States. This report, however, did not cover the Great Lakes, except Lake Ontario. Six years later, a Joint Board of Engineers published a more exhaustive analysis, while in 1928 the National Advisory Council of Canada reported in favour of proceeding with the scheme. Provision was made for the improvement of the St. Lawrence above Montreal, so that it could be used by ocean-going ships, and for the enlargement of the existing channels in the Great Lakes, the whole scheme being planned to combine power development with the most economical use of the river for navigation.

On the river itself, the works fell naturally into three sections. The first of these lay between the Galoup Rapids, near Ogdensburg, New York, and Lake St. Francis. This was called the international section, because, for a distance of over 100 miles, the river in this area forms the frontier between Canada and the United States. Two plans were prepared for its development, which came to be known as the single-stage and the two-stage, and were sponsored, respectively, by the American and Canadian engineers. The first comprised a dam between Barnhart Island and Massena Point, with a power house at each end. Both power houses were to have a capacity of 1,163,000 h.p.; and one was to be in Canada and one in the United States. It was argued that this plan provided better navigational facilities and would give slightly more power at a lower first cost.

The two-stage development comprised the construction of two dams, one at Ogden Island, near the town of Waddington, New York, and one at the upper end of Barnhart Island. A power house with a capacity of 406,400 h.p. was to be erected at the first dam; and there was to be a plant of 1,806,600 h.p. at the lower dam. The arguments in favour of this plan were that it allowed the power to be developed as the demand for it arose, and that this advantage would nearly compensate for the higher cost. It was also stated that less land would be required. At a later stage, as a result of a conference between the Canadian engineers on the Joint Board and the engineers of the Ontario Electric Power Commission, the two-stage plan was modified by abandoning the station at Ogden for one at Crysler Island, which is considerably nearer to Barnhart Island. In the second, or Soulanges, section of the river a combined navigation and power development was proposed, with an initial capacity of 404,000 h.p. and a final capacity of 974,000 h.p.; while at the third section, Lachine Rapids, a navigation canal, 11 miles long, was to be constructed and a power development of 391,000 h.p. was projected. Various other works were also discussed.

It will be seen, therefore, that even on the technical side there were differences of opinion, though not so much in principle as in detail. On the political side, the position was still less satisfactory, for two reasons. As New York is the ocean port for a considerable amount of the outgoing Lake grain traffic, a vociferous party in the United States strongly advocated a route lying entirely in American territory. The ostensible reason for this was safety, but it was strongly suspected that there were two others. In the first place, it was obviously an advantage to the State of New York that as much Lake traffic as possible should pass to its

own great sea port. In the second, it was hoped that the scheme would enable the State barge canal, which put the Lakes into communication with the ocean by way of the Oswego-Erie-Hudson system, to be converted from a liability to an asset. As a matter of history, it is interesting to note that Mr. Roosevelt, then Governor of New York, put forward a proposal for transferring the canal from the State to the Federal Government, as an essential preliminary to the development. Congress then, as it has done more recently, disagreed with the President-to-be and, while not actually rejecting his proposal, stipulated that federalisation should not delay "the St. Lawrence Waterway as the seaway from the Great Lakes to the ocean."

Mr. Roosevelt also took a hand in the project for developing the power of the St. Lawrence, by appointing a commission which reported in favour of a single dam at Massena Point, on the south shore of the river and contiguous to the west end of Cornwall Island, just below Barnhart Island, the site formerly chosen. It was claimed that this would be cheaper than the Crysler-Barnhart Island scheme and would provide for an initial capacity of 600,000 h.p. It did not, however, meet the objections to any single development scheme that had been advanced by the Canadians. These were that, as the flow would be controlled at one power station supplying a large area, restrictions on operation would be difficult and down-river interests would be adversely affected. More land, it was claimed, would be flooded and navigation would be restricted. Moreover, the use of the Massena Point site would have involved a slight adjustment of the international boundary, in order that the power house might be built on United States territory. This would have brought Washington into the picture and have meant the abandonment by the Federal Government of the plan advocated by their own engineers; which was, perhaps, rather too much to expect. Meanwhile, on the Canadian side, both in Quebec and Ontario, the provincial governments had interests which they were unwilling to forego; and sovereign rights, which might not be touched, pertained to the Dominion itself.

On the surface, therefore, prospects for agreement were not very rosy; nevertheless, in 1932, all the difficulties seemed to have been resolved and matters had gone so far that we were able to record the signing of a Treaty between the two countries. This laid down that the works in the international section should comprise the construction of two dams, one at Barnhart Island and another at Crysler Island, on the grounds that this would give better control of the large quantities of water involved, less flooding and lower costs for embankment work. When, however, matters had thus reached a stage at which it seemed real progress might be made, there came a further setback, which has prevented any development for nearly ten years.

Under pressure from the Republican party, the Treaty was rejected by the Senate, although Mr. Hoover described it as "the greatest internal improvement yet undertaken on the North American continent." An attempt to revive the scheme in 1938 was equally unsuccessful, because powerful influences opposed it on the ground that it would mean competition between private concerns and an undertaking financed from public funds. Even now, it is not certain that the project will go through without strenuous opposition; for, although the obstacle of ratification has been circumvented by making an agreement rather than a treaty, money will be required for carrying out the work, and a request for funds is hardly likely to be received with enthusiasm by the politicians. No body likes reversing its previous decisions, and, if pride is subdued on this occasion, it will be because all the parties concerned recognise that national interests must override purely political considerations. To pass the scheme will be to contribute to the war effort of both countries or, if it be argued that this is taking too long-sighted a view, it will undoubtedly prove of great assistance in the work of reconstruction which will be essential in all countries after peace is declared. This, as Lord Halifax pointed out at the Pilgrims Dinner in New York, on Tuesday last, will be a task far beyond the strength of any single country.

THE BATTLE OF THE ATLANTIC.

Mr. Churchill's disclosure, a week ago, that German heavy warships were operating in the Atlantic has been followed up promptly by the German wireless bulletins, with their tales of extensive sinkings of British merchant ships, while the battleships of the Royal Navy vainly attempted to catch up with the elusive Scharnhorst and Gneisenau. What credence should be attached to the details of the German story will doubtless appear in due course; meanwhile, there is no particular reason to doubt that the two ships named were, in fact, at sea and that they may have achieved a certain amount of success in their operations against Allied merchant shipping. What does appear open to question is the motive underlying the use of such heavily armed and armoured vessels for purposes for which they were never designed; and the effect that they are likely to produce on the essential flow of transport across the Atlantic.

Regarded as capital ships, these two vessels are not of exceptional size or fighting power, having a "standard" displacement of only 26,000 tons and a main armament of nine 11-in. guns, mounted in triple turrets. In both size and hitting power, therefore, they are no improvement on the old, but radically modernised, British ships of the Queen Elizabeth and Royal Sovereign classes, which they claim to have eluded after a two-days' "chase." If, indeed, the Germans were "followed for two days," as they claim, by vessels of this type, they should have had no difficulty in escaping action, merely on the basis of their legend speed of 27 knots. The combination of geared turbines, water-tube boilers and oil fuel, which is the standard form of propelling machinery for British warships of any size and power, is capable of great increases on its designed power output; but the Scharnhorst and Gneisenau, unlike the Deutschland and her class, are similarly engined, and it may be supposed that they are equally capable of speeds considerably in excess of their normal maximum. Had the Graf Spee been steam-driven, incidentally, she might well have succeeded in eluding the Ajax and her consorts. It may be concluded, therefore, that the risk of being brought to close action by British ships of equivalent fire-power and protection was not a principal reason for using these vessels rather than cruisers for mere commerce raiding, instead of keeping them in home waters for their legitimate purpose of countering the opposing capital ships of the Royal Navy.

The desire to bring about a dispersal of the British heavy ships might be a sufficient reason if the German and Italian strength in vessels of this class were not so small that it can matter comparatively little to the enemy, whether or not the British battleships and battle cruisers were more widely dispersed than was the case already. It could not have been supposed that they would be employed for convoying ordinary merchant vessels, and much lighter craft than 26,000-ton armoured ships would be quite adequate to deal with the average convoy's escort. All the indications are, therefore, that the Atlantic adventure of the Scharnhorst and Gneisenau was principally inspired by political motives; more especially, the need to pull some new rabbit out of the hat for the encouragement of the German people and the maintenance of German prestige in the eyes of Germany's Allies and possibly wavering associates. For this purpose, it was necessary, obviously, to sink a few merchant ships, and this has evidently been done; but this cannot have been the primary purpose of the sortie, or the raiders would have relied upon the protection of their heavy armament, armour and speed to operate in more congested waters, nearer to the British Isles than they claim to have done, even at the risk of attack by British surface vessels. For the purposes of propaganda, however, it was essential that they should return to their home ports, and return reasonably undamaged. This may also explain the vagueness of the German reference to the "Atlantic islands" as the venue of operations; taken in conjunction with the British official figures of sinkings, it does not appear that the enemy vessels took the risk of frequenting the neighbourhood of the islands which would offer the greatest concentration of merchant shipping. Mr. Churchill mentioned, in fact, that they "have sunk some of our independently-routed ships not sailing in convoy"; though he did not specifically state that no convoys had been attacked by them.

Altogether, it does not seem that the results obtained by the Germans from this expedition, which must have lasted for at least a couple of months, have been commensurate with the means employed or the effort expended. Two such ships, used to the maximum advantage, might well have inflicted many times the direct damage that they appear to have done, and, indirectly, might have paralysed a large part of the traffic of the North and South Atlantic; which, in present circumstances, must be a considerably larger proportion of Allied sea-borne trade than is the case in time of peace. In failing to do so, however, they are merely conforming to the general experience of modern commerce raiding by surface vessels, which has never been so effective, in actual sinkings, as was confidently expected.

The theory of commerce raiding in its modern form, as distinct from the privateering of Napoleonic days, may be said to have originated with the French; possibly as a result of their experiences in the successive wars with Britain, in which the privateers of both sides were tolerably successful. The same mentality which led them to concentrate so strongly, first on the production of torpedo boats and then on submarines, rather than on the heavier types of warship, induced them to develop, in the 'nineties, cruisers specially designed to operate against merchant shipping. The Guichen and the Châteaurenault were vessels of high speed—23 to 24 knots—but of quite moderate armament and no more armour than a protective deck. The latter vessel was designed with some vague idea of resembling a large liner, having a straight stem, a counter stern and pole masts; though the effect was completely spoiled by the four funnels (always a rare feature in the world's mercantile marine) and casings which extended to only half the height of the funnels. Apart from these defects, however, the general design showed a better appreciation of the requirements of a commerce raider than was evident in the case of the Graf Spee and her sisters, which were not so well suited to the role as were the Emden, Karlsruhe, Dresden, and Leipzig of the last war.

The effect of the ocean raider, as Sir Herbert Richmond pointed out in his book, *Sea Power in the Modern World*, is to enforce the need of convoy on ocean routes; and the need of convoy increases the requirements of escorting vessels, while slowing up the flow of trade or, alternatively, increasing the number of cargo vessels necessary to maintain a given traffic. It will be realised, however, that the influence which such increased requirements can exert on the fighting force of a navy is considerably affected by the fighting strength of the navy to which it is opposed. It is arguable, indeed, that the retention of the Scharnhorst and Gneisenau in their own territorial waters, with the knowledge of the British Admiralty, would have been as effective a strategic measure as sending them to sea, from the purely military point of view.

The control of the Atlantic is not likely to be won or lost as a result of the activities of surface raiders, whether warships or disguised merchantmen, against mercantile ships which are already organised and directed to resist the much more serious menace of the submarine, operating in the narrow seas in conjunction with aircraft. Some little success they must be expected to achieve, at a price, but, in general, they can have only a "nuisance value," the effect of which must diminish as counter measures are developed. Nothing that they have yet achieved affects the fundamental dictum that the business of warships is to seek out and destroy or otherwise to immobilise the warships of the enemy; and that, unless and until this is done, mastery of that enemy's seaborne communications cannot be established. The submarine, in skilful hands and sufficient numbers, has threatened the continued validity of this principle more than once, but has not yet displaced it; and there seems no reason to suppose that this war, any more than the last, will relegate Admiral Mahan (not to mention Admiral Lord Nelson) to the limbo of discredited theoreticians.

NOTES.

SHIPBUILDING ON THE GREAT LAKES.

As mentioned in our leading article, on page 251, an agreement has been reached between the United States and Canada which will permit both nations to build army and navy vessels in the shipbuilding yards of the Great Lakes. This agreement may be described as the successful outcome of negotiations which have been going on for the past two years between the two countries. It amounts to a new interpretation of the Rush-Bagot Agreement of 1817, which governs naval operations and armaments in the Great Lakes area. The four conditions laid down in the new agreement are :—The vessels are not intended for service on the Great Lakes. Before beginning construction, each Government must furnish the other with full information concerning any vessel to be constructed in Great Lakes ports. Warships may be built on the Great Lakes with full armaments, but the armaments must be placed in such a condition as to be incapable of immediate use while the vessels remain on the Great Lakes. The vessels must be removed promptly from the Great Lakes upon completion.

ELECTRIC HEATING OF AIR-RAID SHELTERS.

The electrical industry has become rather perturbed at the neglect of the authorities to appreciate the part that electricity can play in the heating of air-raid shelters. To overcome this inertia, the British Electrical Development Association, in co-operation with the Fulham Borough Council Electricity Department, recently arranged a demonstration to test the comparative merits of five types of heater. In view of the low cost of the coal stoves which have been purchased by the Ministry for this purpose, the heaters tested were of the simplest types, the object being to keep the capital cost within the limit of 8*l.* per shelter. Each shelter was of the 50-person size and the heaters were installed during the cold weather in December. As a result, according to the *E.D.A. Bulletin*, it was found that the heaters had to be operated more or less continuously for about a fortnight before the walls and roof became thoroughly dry. The condition of the interior surfaces, it is pointed out, is probably at least as important as air temperature from the point of view of comfort. In addition, the temperature of the floor has considerable influence. From this point of view, as well as to ensure a good distribution of warmth, the use of tubular heaters is advantageous. On the other hand, a type of heater which has some luminous effect undoubtedly has a psychological appeal. For this reason, a wall-type fire was very popular, but it is doubtful whether a fire of the ordinary type is sufficiently safe, even in shelters where the bunks are fixed in such positions as to allow some space around it. After the shelters had been completely dried out, all the heaters installed were capable of producing a temperature rise of at least 20 deg. F. when the outside air was at freezing point, and provided a sufficient degree of comfort for the occupants. The demonstration accordingly showed that either tubular heaters or convectors with a loading of approximately 1 watt per cubic foot, *i.e.*, a loading of 2 kW to 2½ kW, are suitable for a 50-person surface shelter. It is thought that, in view of the limited number of fans which can be manufactured in war time, the unit type of heater consisting of a double fan and heater element, arranged to discharge warm air in opposite directions, should only be employed in trench and other underground shelters, where there is more need for positive ventilation and where the heat losses from the structure are less than in the case of surface shelters. An alternative arrangement is to install tubular heaters or convectors in the trench and to provide positive ventilation by fixing plain extraction fans in the escape hatches.

THE INSTITUTION OF MECHANICAL ENGINEERS BENEVOLENT FUND.

A meeting of the members of the Benevolent Fund of the Institution of Mechanical Engineers was held on Friday, March 21, at Storey's-gate, St. James's Park, London, S.W.1, to consider the report of the Committee of Management for the year 1940. The chair was occupied by the President of the Institution, Mr. W. A. Stanier. The Report showed that the membership totalled 2,424 names, as against 2,236 for the previous year, or 17 per cent. of the total membership of the Institution. The revenue amounted to 2,910*l.*, as compared with 2,704*l.* for the preceding year. A few additional donations had been made to the Silver Jubilee Appeal Fund, which stood at 2,834*l.* Legacies amounting to 225*l.* had been received. The committee had assisted 59 cases of distress during the year, and the financial position had made it possible to supplement the allowances by 15 per cent. to meet the increases in the cost of living. The committee, however, repeated its urgent appeal to members of the Institution not at present helping the Benevolent Fund to become members of it. The losses during the year comprised 8 life members and 23 ordinary members. Among these were Sir Robert A. Hadfield, who had been a most generous supporter, and Mr. G. E. Wolstenholme, member of the Committee of Management. In response to an invitation from the Southern Branch at Portsmouth, the deputy-chairman, Major P. J. Cowan, had addressed a meeting there on the aims and work of the Fund. The clerk to the committee, Mr. F. W. White, had resigned through ill-health, and the committee recorded its great appreciation of his services. Steps had been taken for the honorary secretary to become a Life Governor of the Royal Asylum of St. Ann's Society, in order that he might sponsor applications for educational grants. The report was duly adopted. Three members of the Committee of Management, namely, Major P. J. Cowan, M.B.E., Mr. W. J. Tennant, and Sir H. Nigel Gresley, C.B.E., retired by rotation and were not eligible for immediate re-election. A further vacancy was caused by the death of Mr. G. E. Wolstenholme. Mr. Asa Binns, Sir Francis Carnegie, C.B.E., Mr. W. A. Tookey, and Mr. Thomas Walley were elected to fill these vacancies. The honorary treasurer, Mr. W. O. Roberts ; the honorary secretary, Mr. J. E. Montgomrey, B.Sc. (Eng.) ; and the honorary auditor, Mr. Raymond Crane, F.C.A., were re-elected. Brigadier-General Magnus Mowat, C.B.E., will continue to represent the Fund on the Professional Classes Aid Council, sponsoring cases in which that body has been of assistance.

ARCHITECTS AND RECONSTRUCTION.

It is a matter of common observation that the present war differs from all that have preceded it in the amount and the widespread character of the physical reconstruction that will be necessary at its conclusion, merely to enable the ordinary work of the community to be resumed under something approaching normal conditions. Apart from the buildings that have been actually demolished, probably three or four times their number have been damaged to an extent that makes reconditioning not worth while, even though they may continue in use until alternative accommodation becomes available. While general reconstruction policy has been placed in the hands of the Ministry of Works and Buildings, the detail work must depend largely upon the individual architect. To emphasize the importance of employing the best available talent and experience on this work, the Royal Institute of British Architects has submitted a memorandum to the Minister, Lord Reith, expressing appreciation of the general principles that policy must precede planning, planning must precede execution, and full use must be made of all the elements comprising the building industry. The policy of the Institute, the memorandum continues, is co-operation with the Government agencies charged with the solution of these problems and offers its experience and assistance, not only as a unit of the industry, but also in its own specialised field ; while it feels that its duty to the community gives it the right to ask that its resources and experience shall be consulted by the Government as a preliminary to any far-reaching decisions on building and rebuilding policy. The Royal Institute is setting up a special committee to deal with the present problems and has asked the Minister to indicate what would be the most practical method of offering to the Government its immediate co-operation and assistance in the initial stages of formulating reconstruction policy. In acknowledging receipt of the memorandum, Lord Reith has stated that he is anxious to avail himself of all that the committee can contribute to this national task and has invited the President of the Royal Institute of British Architects (Mr. W. H. Ansell) to meet him, accompanied by representative members of the committee.

THE BRITISH EMPIRE CHAMBER OF COMMERCE IN THE UNITED STATES.

The Executive Board of the British Empire Chamber of Commerce in the United States of America (Incorporated), the office of which is at 587, Fifth-avenue, New York, has adopted a proposal to set up a separate section within its organisation to concentrate upon the development and encouragement of British export trade to the United States and the particular problems affecting it at the present time. The new section will be under the direction of Mr. Frederic W. Moss, president of Messrs. Stanco, Incorporated. Its functions will be (*a*) the investigation of openings for increasing existing trade and developing new possibilities ; (*b*) publicising available sources of supply of British goods of all kinds, and facilitating the use of existing machinery to maintain the supply and speed up delivery ; (*c*) co-operation with, and supplying information to, all organisations or individuals who are promoting the sale of British goods ; (*d*) to consider and report on suggestions and plans directed to the encouragement of the use of British goods, and to improving the methods by which they are made available to and suitable for this market ; and (*e*) to provide a central organisation, which will act as a connecting link between the various interests, official and otherwise, concerned with British export trade in the United States. Mr. Moss has been authorised by the Board to set up a competent consultative committee, covering all branches of his contemplated activities, to assist him in this work.

WAR-TIME INVENTIONS.

The stimulus that war always provides to the inventive faculties of a large proportion of the peoples engaged may produce only a minute percentage of serviceable ideas, but it is more than usually important that their practicability should be examined with the minimum of delay. A serious obstacle in the path of the average inventor, however, is the difficulty of ascertaining how best to proceed to present his invention in the appropriate quarter. In many cases, too, it may happen that he is hampered by a lack of knowledge of the progress already made in the same direction, or of the facilities available for submitting his invention to the preliminary testing which is desirable before seeking to interest others in it. To assist their members in regard to these and cognate matters, various technical institutions have set up Inventions Committees. That of the Institution of Mechanical Engineers was appointed shortly before the war, with the idea of general rather than specifically war-time utility. Since the outbreak of war, however, the advantages of such committees have become more widely appreciated and their number has increased, the most recent, we believe, being that of the Junior Institution of Engineers. As an instance of the scope of such a committee's terms of reference may be cited those of the committee appointed by the Council of the North-East Coast Institution of Engineers and Shipbuilders, which consists of 12 members. The functions of the committee, as laid down by the Council, include the issuing of a general invitation to members of the institution to submit ideas or inventions in engineering and shipbuilding ; the expression to such members of opinions on ideas or inventions submitted ; the making of suggestions for testing inventions, and bringing together the inventor and those who might work out his idea in practical form ; and, subject to the inventor's approval, and the Council's authority, the submission of suitable inventions for the consideration of appropriate Government departments. An essential requirement of this committee, as of the others with similar objects, is that any idea or invention submitted for consideration shall have previously received at least provisional patent protection.

LETTER TO THE EDITOR.

FARADAY'S "BABY."

TO THE EDITOR OF ENGINEERING.

SIR,—No anecdote is more frequently retold than that of Michael Faraday's retort to the inquirer who asked what was the use of his discovery of electromagnetic induction—"What is the use of a new-born babe?" It was repeated once again on Sunday last in the B.B.C. broadcast, "Everybody's Scrap-Book." A different attribution is given, however, by C. C. Colton, in his collection of miscellanea, *Lacon: or Many Things in Few Words*. Item CCCCIV in this collection asserts that "When the air balloon was first discovered, some one flippantly asked Dr. Franklin what was the use of it? The doctor answered this question by asking another: 'What is the use of a new born infant? It may become a man.'" I have not access to a first edition of *Lacon*, which was originally published 1820-22; but my own copy was printed in 1826, *i.e.*, five years before the date of Faraday's great discovery. It is unlikely that Colton—satirist, essayist, wine merchant and sometime vicar of Kew—had the story at first hand; more probably he was merely repeating gossip of the day, or something that he had read. Was Faraday doing the same; perhaps, quoting Colton without acknowledgment? Acknowledgment would not be thought necessary in a chance conversation, and whoever was responsible for giving the tale a wider currency may not have recognised that it was a quotation.

Yours faithfully,

CURIOUS.

March 24, 1941.

OBITUARY.

MR. F. E. BROWN.

WE regret to record the death at his home at Somerfield, Holmfirth, on March 13, of Mr. Francis Edwin Brown, chairman of Messrs. David Brown and Sons (Huddersfield), Limited, and their associated companies. Mr. Brown, who was 67 years of age, first joined the company, which was founded by his father in 1860, as an apprentice, in January, 1889, and the business of David Brown and Sons in its present form was originated by him. He was a pioneer in the development of machine-cut gearing, which was a logical outcome of the first machine that the company had designed and made for them, for cutting teeth in the wooden gear patterns in which they specialised at that time. The next step was the adoption of the same machinery for cutting the teeth in mortice gears, where hornbeam teeth were wedged into the cast-iron rims and the teeth afterwards machine cut.

Mr. Brown's earlier experience was obtained during the period when tooth shapes were still determined on the drawing board and methods of generation were unknown. Experiments were based at first on cycloidal formations. Various odontographic methods of tooth-shape determination were employed and many special forms were tried. It was largely due to the efforts of Mr. Brown and his colleagues that standardisation was eventually achieved. He early realised the possibility of cutting teeth in metal patterns and then in the actual running gears. This led to the acquisition of the site of the present works, Park Works, at Huddersfield, in 1900. In 1903, Mr. Brown prepared the first general gear catalogue issued by the company. This came to be regarded as a text-book on the subject; in fact, a number of them are in use to this day.

The wide use now made of worm gearing owes much to his initiative. In his early days, it was regarded as a means of obtaining a right-angle drive of high ratio, but one which was of low efficiency and, therefore, should be used only as a last resort. Experiment in the use of the correct materials, and the parallel development of special machinery, gave such successful results that he was able to establish worm gears as the rear-axle drives for the London 'buses, since when worm gearing has become accepted as a reliable and versatile drive for all types of transmissions. Due to his stimulus, much research work was done on helical gears and the plant for producing them, with the result that the firm was in a position to supply main propulsion gearing for ships when the geared-turbine drive was introduced.

Mr. Brown made many trips overseas to study American and Continental methods of manufacture. This led to valuable interchanges of ideas and, about 1912, to an arrangement with the Timken Detroit Axle Company to manufacture "David Brown" worm gears in the United States for the rear-axle drives of many American vehicles. Complete batteries of the company's special-purpose machines for worm-gear production were exported to America for their manufacture. Other developments were the acquisition of the Keighley Gear Company and the Salford Rolling Mills of P. R. Jackson and Company, Limited, and the development of the alloy-steel foundries at Penistone. He realised that the best use could only be made of many types of gearing by parallel progress in the manufacture of gear materials.

THE LATE MR. F. E. BROWN.

Mr. Brown's business activities left him no time for public life, but he took a keen interest in agriculture and horticulture. His interest in the former was shown by his association, with his son, Mr. David Brown, managing director of the David Brown group of companies, in the production of the David Brown tractor, described on page 73 of our 148th volume (1939). The welfare of the personnel of the David Brown companies was a matter of personal concern to him; in particular, Mr. Brown was a well-known figure at the Motor Shows from their early days, in 1906, when the firm became members. He was president of the Huddersfield Engineering Employers' Association in 1921 and 1922, and the first chairman of the Huddersfield branch of the Foremen's Mutual Benefit Society.

AIR-RAID DAMAGE IN GERMANY.

ALTHOUGH periodical attempts continue to be made to induce the operational staff of the Royal Air Force to bomb Berlin and other German cities more or less indiscriminately, as the Luftwaffe have bombed London and other large British centres of population, in the belief that this change of policy would bring home the folly of war more directly to the German population as a whole, the efforts of the Royal Air Force continue to be directed to the main object of causing as much damage as possible to the German industrial machine. According to an official statement recently issued, dealing with the operations against Germany during December and January, there is every reason to believe that the damage caused to the enemy in this way has been substantial and has exceeded the damage that German air attacks inflicted on British industry, in spite of the fact that bad weather somewhat restricted the scale of the British raids on Germany during the period in question. Reports from Berlin, states the official survey, indicate that the raids on that city on December 15 and December 20 were the most effective carried out up to that time. Mannheim was heavily attacked during the week before Christmas and Bremen at the New Year, while Wilhelmshaven was heavily raided in the middle of January. Lesser attacks were made on various Rhineland towns, especially Düsseldorf. The sketch map, opposite, indicates the principal targets in Germany during these two months.

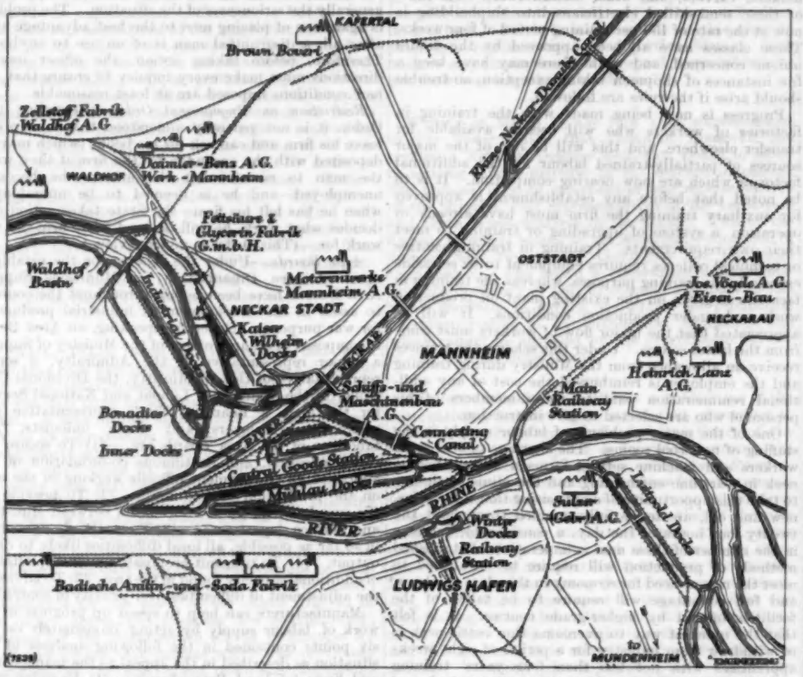
In the course of the December raids on Berlin, heavy bombs in the Tauentzienstrasse, in the heart of the city, penetrated to the Unterbahn and brought traffic to a standstill on the important stretch between the Wittenberg Platz and Zoo stations, besides damaging shops and bringing all street traffic to a standstill. The damage was so extensive that it took ten days to clear up, in spite of the extraordinary speed and efficiency of the German salvage squads. Hits were also obtained on a very important railway junction between the Schoneberg and Papestrasse stations, where the Ringbahn connects with the Potsdamer terminus station. While railway damage is in most cases quickly repaired, there is reason to believe that this incident caused considerable dislocation by reason of the importance of the sector of the line and the fact that a train was involved. Elsewhere in Berlin, the Police Presidency and the Law Courts suffered some damage, the top floors of the Wertheim department stores were burnt out and minor damage was inflicted on a number of important industrial establishments.

Mannheim, the most important industrial and commercial centre on the middle Rhine, suffered much more heavily. The old town of Mannheim proper stands on the spit of land where the river Neckar runs into the Rhine from the south east. Between the two rivers is the river port of Mannheim and the shipyard of the Schiffs-und Maschinenbau A.G., which has built many of the steamers that now ply on the Rhine. Just to the south of the old town are the main railway station and the extensive engineering works of Heinrich Lanz A.G. On the east bank of the Rhine and the north of the Neckar are the industrial suburbs of Waldhof, Kafertal, and Neckarstadt, with the Industrie Hafen. In this area are the principle works of the Zellstoff-Fabrik-Waldhof A.G. pulp and paper combine; also the important Diesel-engine and lorry works of the Daimler-Benz group and the works of the Motorenwerke-Mannheim A.G., which produces a somewhat similar range of oil engines. In Kafertal are the Brown-Boveri works, manufacturing heavy electrical equipment.

To the south of Mannheim and still on the east bank of the Rhine, are the industrial suburbs of Neckarau and Rheinau and the Rheinau inland port. In this area are the steelworks of the Stahlwerk Mannheim A.G., the soap works of the Sunlicht Gesellschaft A.G., several chemical works, including the important works of the Chemische-Fabrik Buckau A.G., and the important electricity generating station of the Grosskraftwerk Mannheim A.G. It was in Rheinau that the Bergius oil-from-coal process was first developed. The experimental works is still there and has recently been devoted to the production of sugar from wood on a semi-commercial scale.

On the opposite bank are the towns and suburbs of Ludwigshafen, Oppau and Mundenheim, which rank as part of Mannheim industrial area. Here, again, there is an extensive inland port, but the chief industrial features are the enormous chemical works in Ludwigshafen and Oppau. The Badische Anilin-und-Soda Fabrik, at Ludwigshafen (a branch of I.G. Farbenindustrie), includes one of the largest sulphuric-acid plants in Germany. The adjacent Oppau works comprise a large synthetic-ammonia plant (the first full-scale plant using the Haber-Bosch process to be erected), and an alkali plant, and produce a vast range of heavy and other chemicals. Also in Ludwigshafen is another important engineering firm, a branch of the Sulzer works at Winterthür. At Mundenheim, the alu-

AIR-RAID DAMAGE IN GERMANY.



mina works of Gebr. Giulini constitute an important unit of the German aluminium industry. Mannheim is the largest inland port in Europe after Duisburg-Ruhrort. There are the usual flour mills, granaries, seed-crushing plants, oil-storage depots, cold stores and warehouses which are to be found at all large distributional centres. As a railway centre, also, Mannheim is of great importance, its double bridge forming one of the principal Rhine crossings.

The raids on Mannheim have inflicted widespread damage to the installations of the main docks. The shipyards of the Schiff-und Maschinenbau A.G. have been damaged and production has been held up. More than one shop of the Heinrich Lanz engineering works has been completely destroyed and others have been damaged by high-explosive and fire. The damage inflicted on plant and buildings at this works is believed to run into millions of marks and production is likely to be affected for some time. The Ludwigshafen works of the Badische Anilin-und Soda Fabrik have been extensively damaged and the Oppau works have also suffered. There is reason to believe that the damage inflicted on these works has set the German chemical industry some difficult problems. Other works, including the Zellstoff-Fabrik-Waldhof, have received minor damage. Several hits were scored on the main passenger station and the main goods station at Mannheim. Near the latter, a direct hit was obtained on a shed which housed the Central Field Post Office for the Army of Occupation in France, necessitating its removal to Stuttgart. In the goods station, an ammunition train was involved.

Apart from the main station, the Ludwigshafen and Waldhof stations were damaged, the former being set on fire, while the engine sheds were also hit. Altogether, some 15 hits were scored on railway tracks in various parts of the Mannheim area. One of these broke the connection across the Rhine between Mannheim and Ludwigshafen for some days. All rail traffic had to be diverted from the Mannheim area and routed through Karlsruhe—not a serious diversion in point of distance, but Karlsruhe is likely to have been heavily loaded already.

EXPORTS OF MOTOR VEHICLES.—During December, 1940, the value of the new commercial motor vehicles exported from the United Kingdom amounted to 63,970*l*. In the same month, the value of the commercial chassis exported totalled 24,420*l*.

MUNITIONS LABOUR SUPPLY ORGANISATION.*

By W. H. DEXHOLM, A.M.I.Mech.E.

THE change-over in production for the war effort created a big demand for machine tools and quantities of accurate gauges, jigs and tools; and this extra load on the equipment manufacturers naturally increased the demand for the highest grade of skilled labour. Skilled engineers are also required for the maintenance of the equipment of the Mechanised Forces, and this demand will increase as the equipment increases. The first objective, therefore, is to distribute the available skilled labour to the best advantage throughout the engineering industry, and in this connection the Ministry of Labour and National Service has been entrusted by Parliament with very wide powers to establish for the purpose an organisation having a special application to engineering. The principal basis of the organisation is provided by the Employment Exchange service, but this has been supplemented by (1) Inspectors of Labour Supply, and (2) Labour Supply Committees.

Inspectorate.—The Inspectors of Labour Supply, better known as the Inspectorate, act as the direct contact between the labour supply organisation and the factories. Their primary purpose is to ensure the efficient use and distribution of labour in essential industries. Most of the inspectors are allocated to definite areas, and they operate in close co-operation with the Employment Exchange in each area. Specialist inspectors are included in connection with large organisations. Co-operative and insurance societies and collieries are also covered. Training in technical colleges has its specialised group, while trade union inspectors are included to lubricate the machinery of dilution, etc. All these officers are men of considerable and wide experience in engineering production and management, and their principal duties are:—(1) To examine demands for labour made by individual firms, and to determine whether they are justified in the light of the work to be undertaken. (2) In respect of demands for skilled labour, to determine to what extent the firm concerned can meet its own need by:—(*a*) Redistribution of skilled workers already in its employment; (*b*) upgrading of semi-skilled workers; (*c*) subdivision of processes and adjusting the firm's demands accordingly. (3) To inspect firms which employ skilled labour to determine to what extent such labour can be released. (4) To stimulate training by employers in their workshops, and by the full use of local facilities in technical institutes, etc. (5) To investigate, when required, alleged infringement of the Undertakings (Restriction on Engagement) Order. (6) To investigate, when required, departures from trade practices notified under the Conditions of Employment and National Arbitration Order, 1940. In addition, inspectors may be required in the course of their investigation to undertake special inquiries, such as the work performed by particular men whose calling-up for military service has been deferred or who are stated to be reserved by the Schedule of Reserved Occupations.

The complex nature of the investigations to be undertaken leave much to the initiative and common sense of the inspector concerned, and his value to the department depends largely on the manner and extent to which he exercises these powers. Investigations must be conducted with tact, and so far as possible the inspector's aim is to secure the agreement of the firms inspected to any changes. In making their investigations, inspectors have to bear in mind that the efficient use of skilled labour is essential for the achievement of the production programme of the various supply departments, and they must insist that no skilled man shall be called upon to exercise his skill on work or operations which could be handled by a person of a lower grade of skill. To secure this result, it may be necessary to advise the management to split operations, so that roughing out and semi-finishing operations can be carried out by workers with the appropriate degree of skill and training. Further, if inspectors come to the conclusion that any works has more skilled workers than are absolutely necessary, it is their duty to report the matter so that such workers can be transferred to other establishments where there is an unsatisfied demand. It is also the duty of these officers to find among the workmen, persons who are likely to make good instructors in the Ministry's training centres.

In all cases where an inspector believes that labour can be released from a firm, the matter is discussed with the management concerned in the release. Failure to reach agreement is referred to the Labour Supply Committee for further discussion and action to be taken as necessary. It is important that, immediately agreement is reached between inspectors and management, the local Exchange manager should be given full particulars so that transfer can be effected. Certain excepted key occupations are reported back to Head Office so that the Supply Committee can place them to the best advantage through the appropriate Employment Exchange. In co-operation with the various Exchanges, inspectors arrange panels of investigation at which the details of each man's experience are card-indexed and noted for placing either for training or directly in industry. Each inspector is provided with an identification and admission card which carries with it very strong powers enabling him to enter and inspect any premises used for or in connection with any undertaking; to inspect the books, records, and other documents relating to the undertaking; and to demand such information relating to the undertaking as may be required for any of the purposes aforesaid.

Labour Supply Committees.—These have been established in the more important areas from the point of view of war production. These committees are responsible to the Divisional Controller and work in conjunction with the local Exchanges and the Inspectorate. The committees consist of a chief labour supply officer, other labour supply officers, varying in number, and a local welfare officer. These committees deal with the general field of labour supply in their respective areas, except that they are not concerned with dock labour supply. Their main duties are:—(1) To survey the labour position in their area in relation to the directions received from headquarters or area boards in order to assess the relative urgency of demands for labour. (2) To secure the best use of skilled labour by arranging through the Employment Exchange machinery for the transfer of workers from one factory to another as required, and by securing the employment of additional unskilled labour, including women. (3) To stimulate arrangements for welfare, including lodging accommodation and billeting, by approach to local authorities, voluntary organisations, and other local bodies. (4) To stimulate training of workpeople, by ensuring that full use is made of facilities available in the area for that purpose.

To correlate the functions of both Inspectorate and Labour Supply Committees, an engineering illustration may be taken. When a firm requires workers, they place their demands in the hands of the local Exchange, when the demand will, if possible, be supplied for work of national importance. Consideration, of course, is given to the urgency of these demands. If it is not possible to fill the vacancy from unemployed workers on the local register or from employed workers on the register who are not engaged on essential work, immediate approach is made to Group Clearing Area or Area Clearing House, or again, the demand is circulated in the other Exchanges.

If the local officer considers that the vacancies are too urgent to permit of circulation, the manager must report to the chief labour supply officer for the area concerned, in order that the matter may be considered

* Paper read before the Institution of Mechanical Engineers, on Friday, March 21. Abridged.

by the Supply Committee; and full particulars are given of previous action taken to meet the demand. The Supply Committee after consideration may pass the case to the Chief Divisional Inspector to arrange for full inspection. The inspector then reports whether it is necessary to fill the demand or not, and the Committee takes the appropriate action to meet the demand, notifies the firm what action they must take to meet it themselves, or arranges for transfer from other sources of supply, such as a pool formed by previous inspection of other factories. Where agreement cannot be reached between Committee and firm the case is reported to the Divisional Controller at head office for decision and action.

It has been stated how necessary it is to spread out the skilled labour by release from one shop to another and to help to equip new factories as the need arises, but there is still a large proportion of skilled labour engaged on work which is not skilled in the true sense and which, given goodwill on both sides, could quite well be dealt with by semi-skilled or unskilled labour. There are many opportunities for managements to upgrade their workers so that untrained workers can become machine operators, thus enabling machine operators to be upgraded to machine setters; journeymen can be promoted to chargehands, chargehands to foremen, and so on. First-class turners and fitters on production should be upgraded to tool rooms where the shortage in skilled workers is most acute. As a simple illustration of the application of dilution, the case of a number of turret lathes operated by setter operators can be quoted. These men can set for themselves; therefore they can set for others, such as women operators, and by placing one setter operator in charge of four or more of these machines the skill of the setter is being used to the best advantage.

It is generally accepted that women can be employed with advantage on machine and bench work of a repetitive nature, and the employers can do a great deal towards the successful employment of women by reducing the fatigue factor to a minimum. In one factory, 6-in. shells are being produced by women. The shells are loaded by high-speed electric cranes set in the middle of the shop, each crane being operated by a girl in an elevated box so that she looks down on each of the six machines being loaded or unloaded. The transport from one crane bay to another is done by conveyor belt and in no case is the shell handled by the girls, except merely to guide it in or out of the machine fixture. Where women are employed, employers consider that this type of labour is giving great satisfaction. They are not affected by monotonous repetition, keep to their work all the time, and there are very few instances of trouble in the shops. The field of work covered ranges from general labouring, crane driving and storekeeping to the skilled requirements of optical grinding and inspecting to fine limits.

Training.—The Ministry of Labour have consistently insisted that firms must train their own workers and help to train for others; but the Government have established numerous training centres throughout the country, giving a course lasting from four to six months, according to the ability of the individual. Machine operating is taught on centre, capstan, and turret lathes, milling machines, grinding machines, etc. An excellent training is also given in fitting, instrument making, sheet-metal work, and welding. The trainees are drawn, in the main, from non-essential occupations. They include clerks, travellers, and other black-coated workers, and arrangements are completed for filling all places at these establishments with women as far as possible. Where it is necessary for the trainee to live away from home, the Ministry pays weekly allowances, which vary according to age. Instructors for these establishments are required and managements must consider the advisability of releasing certain highly-skilled types of men who are capable of imparting to others the knowledge necessary to equip the trainees to take their place in industry.

Technical training given at certain colleges is of an intensive nature and lasts for a period of 8 to 10 weeks. A typical case is cited. By permission and co-operation of the various educational authorities, committees, governors and directors, machines were removed from certain schools and centralised at four of these colleges. Several firms have loaned machines to the colleges for the purpose of training. Arrangements have been completed to treble shift the colleges, and it is expected that the next batch will number about 750 trainees per period of eight weeks. It will be seen, therefore, that the estimated annual output of these four colleges will be in the region of 4,500 persons per annum, rising to 10,000 as the scheme develops and further machine tools become available for new centres.

The subjects taught are reading of drawings, micrometer and vernier, and the operation of various types of machines, such as lathes, milling, drilling, planing, shaping, slotting, and grinding machines. There is also a special class for training in engineering inspection, light profile and snap gauge making, and surface table work. Another class in operation at one of the colleges is for training ship electricians. The type of labour used comprises joiners, carpenters, cabinet makers, carvers, and other woodworkers. The flow of these semi-skilled electricians into shipbuilding is now at the rate of 150 per training period of four weeks. These classes have all been approved by the trades unions concerned, and while there may have been a few instances of shopmen taking exception, no trouble should arise if the rules are followed.

Progress is now being made with the training in factories of workers who will become available for transfer elsewhere, and this will be one of the major sources of partially-trained labour for the additional factories which are now nearing completion. It is to be noted that before any establishment is approved for auxiliary training the firm must have already in operation a system of upgrading or training to meet their own requirements. Training in training centres or technical colleges requires equipment to be set aside especially for training purposes, whereas the training in factories is given on the existing plant on production work and under production conditions. It will be appreciated that the major flow of workers must come from the latter source. Under this scheme the trainees receive an allowance from the Ministry during training and the employer is reimbursed the cost of any additional remuneration paid to those members of his personnel who are selected to give instruction.

One of the major problems of labour supply is the staffing of new tool rooms. The shortage of tool-room workers and machine setters forms a serious bottleneck in war-time engineering and the Ministry desires to take this opportunity of emphasising that if factories, new and old, are to be fully manned throughout the twenty-four hours of the day, a considerable increase in the number of these men is imperative. Established methods of production will require to be altered to meet the urgent need for economy in this class of labour, and full advantage will require to be taken of the facilities offered by higher-grade courses. It is felt that the quickest way to overcome this bottle-neck is to withdraw from industry for a period of eight weeks apprentices with not less than four years' training and give them an intensive course in a technical college on precision measurements, interpretation of drawings, gauge making, and all other details connected with tool-room work. As these youths already have the necessary groundwork, it is considered that their reaction will be very rapid and at the end of eight weeks any average apprentice fitter will be fully qualified to fill one of the many gaps in tool rooms which are so important to our productive effort. Under the scheme, as outlined, the employer will continue to pay the apprentice his normal wage during the training period and the Ministry will pay the technical college an adequate rate per student hour for the training given.

A considerable demand will arise for women supervisors for female labour, who will be called upon to deal with matters of welfare, discipline, and in many cases simple instruction. To meet these requirements, selected women who have volunteered for industry should be given additional intensive training to enable them to qualify as supervisors. The women selected must have suitable educational qualifications and the necessary personality to take charge. The training to be given includes machine-tool operation, engineering inspection, and first-aid work.

Priority.—Every manufacturer who is capable of undertaking war work must sacrifice his ordinary peace-time trade and devote his whole energy to the war effort. For our guidance the Department has issued a Priority List which may alter as the conditions vary, but industry has a lead from the Ministry on the speed-up of aircraft production. From a priority point of view, skilled men must be taken without delay and drafted to the most important work. This should be done as far as possible locally, as disturbances of homes and waste of time in travelling, etc., is to be avoided. Firms employing skilled men on non-essential work must offer their services immediately. Generally speaking, it can be said that industrial types are found in definite areas or districts, and there is no reason why a give-and-take policy—or, say, a transfer system—cannot be arranged in any district so that when one shop becomes slack, due perhaps to want of material, orders, etc., the skilled labour can be available immediately for any other firm in the district which may require an extra supply for a double shift or triple shift. This could be arranged between managements, and transfers could be effected through local employment exchanges without any trouble. A system of transfer is in operation at present in the shipbuilding industry. When one ship is completed the tradesmen are transferred to another yard to assist in completing the other ships quickly. In any case, there is no reason to wait for Government inspection.

In transferring labour it may be found that men will not move from one district to another, or after transfer will not remain there, or may leave their present occupation for another without availing themselves of the machinery set up for the purpose. Then it may be necessary to use the drastic power of direction. This power has only been used in a very few instances, due, no doubt, to the fact that workers do appreciate generally the seriousness of the situation. The problem is again one of placing men to the best advantage and, after all, a disgruntled man is of no use to anybody. Therefore, before taking action, the officer issuing directions must make every inquiry to ensure that the new conditions imposed are at least reasonable.

Restriction on Engagement Order.—Regarding this Order, it is not generally understood that a man can leave his firm and can ask for his books (which may be deposited with the exchange by the firm if they want the man to remain) but the minute he becomes unemployed—and he is deemed to be unemployed when he has left his firm—the State takes action and decides what work he will do, and what firm he will work for. (This Order is under review.)

Area Boards.—Under the scheme for the establishment of Area Organisation for Munitions Supply, Area Boards have been set up throughout the country to assist in the development of industrial production for war purposes. Generally speaking, an Area Board is composed of an area officer of the Ministry of Supply, a senior representative of the Admiralty, a senior representative of the Air Ministry, the Divisional Controller of the Ministry of Labour and National Service for the area, a Board of Trade representative and prominent employers and trade unionists. The functions of the Area Boards are:—(1) To secure the rapid, effectual, and continuous co-ordination of the efforts of all Government officials working in the area on the production of war stores. (2) To provide for the speedy exchange of information between Ministries and Service departments. (3) To settle, by agreement in so far as possible, all local difficulties likely to delay output. (4) To transmit proposals for the exploitation of additional capacity found in the area. (5) To advise on the adjustment of difficulties over priority of contracts.

Manufacturers can help to speed up progress in the work of labour supply by acting immediately on the six points contained in the following analysis of the situation as described in the appeal to the management and firms by Lord Beaverbrook:—(1) Examine your whole labour structure with the object of expanding the productive effort of the men employed by you. By upgrading men of less experience, you can release the most highly skilled workers, either for additional output from your own factory, or for transfer elsewhere. (2) Consider how far you can "break down" operations so that the jobs can be done by workers of less skill. (3) Establish within your factory facilities for training new entrants to the industry and training up existing employees to skilled work to the maximum degree compatible with efficiency. (4) Reconsider any demands for skilled labour you have already made on the employment exchange and cut them down to the minimum necessary in the light of the preceding paragraph. Also, report to the employment exchange the labour you can release even temporarily. (5) Welcome and give every possible assistance to the officers of the Ministry of Labour when they visit your works. They will ask for your co-operation in any proposals they may have to make, but they will have in mind the needs of the nation rather than the needs of any particular firm. Where Labour Supply Committees have been set up you will have an opportunity of stating your case to the Committee if you do not agree with the inspector. If you feel that the proposals made will interfere with the work you are doing for a production department and if you are unable to reach agreement with the Ministry of Labour officials the Area Officer of the production department is available to advise you. (6) Assist, if so requested, in locating men suitable to work as instructors in Government training centres.

WELDED STEEL-FRAMED CARILLON TOWER.—Particulars of a welded steel-framed carillon tower, which is cruciform in section, have recently been furnished to us by Messrs. The Lincoln Electric Company, Limited, who supplied the shielded arc electrodes and welding equipment for the work. The structure consists of a group of five towers faced with stone and the welded-steel framework weighs 102 tons and is 157 ft. 6 in. high. The centre pole tower has cross arms consisting of 5-ton double-webbed welded girders and carries 32 bells, which weigh 22 tons. Each of the four main steel towers consists of five arc-welded sections, an upper one of 27 ft., three intermediate sections, each 35 ft. in length, and a lower section of 25 ft. 6 in. Each tower measures 3 ft. 6 in. by 6 ft. at the base, tapering to 3 ft. 6 in. by 4 ft. at the top. Angles are used as the vertical and horizontal members and as diagonals. The horizontal angles have their flanges extending outwards to serve as supports for the stone facing The angles at the base of each frame measure 8 in. by 8 in. by 1¼ in., and at the top 8 in. by 8 in. by ¾ in. The overall width of the tower is 30 ft. The carillon was presented to the City of Dayton, U.S.A., by Mrs. E. A. Leeds, wife of the President of the National Cash Register Company.

LABOUR NOTES.

THE Government's plans for the concentration of industry were explained at conferences in London last week with representatives of the employers and workpeople in the industries concerned. The method of concentration is to be by the constitution of "nucleus firms," whose labour will be protected against transference to munitions, their raw material supplies safeguarded, and their factories protected, as far as possible, against requisition. They will be assisted by a liberal policy of deferment in the calling up of men for the Armed Forces and efforts will be made to concentrate Government orders on them. Undertakings which are not "nucleus firms" will not be eligible for inclusion in the protected list. They will be expected to contribute labour for transference schemes; Government orders will be diverted from them; a list of their factories will be sent to departments seeking factories to requisition; and no help will be given them to obtain raw materials.

A White Paper issued on Wednesday last week stated that each firm desiring to qualify as a "nucleus firm" must make arrangements with others to enable it to run full time or as nearly so as circumstances permit. A firm owning several factories may concentrate its own production to obtain full-time working. Arrangements can, and should, be made, it was pointed out, by small firms as well as large organisations and every help will be given to the smaller firm in dealing with their special problems. The following conditions, it was stated, would also be required of a "nucleus firm":—Provision for the complete closing down of the factory or works whose output is to be transferred; its own financial arrangements to compensate the firm or firms whose works are to be closed; arrangements for the plant of the closed firm to be kept intact unless the premises are requisitioned; provision for the maintenance of the production for export and for the Government which was previously undertaken by the firm closed down; arrangements for dealing with the workers affected by the scheme must be satisfactory.

In order to comply with the last of these conditions, firms will be required by the Board of Trade and the Ministry of Labour and National Service to ensure that production is concentrated as far as possible in areas where the competing demands of the munitions industries are least severe; that the labour released is adaptable and of a type likely to be readily absorbed in the new employment; that the labour displaced from factories closed down and which cannot be absorbed into war industries shall, as far as possible, be taken on in the factories remaining in production; that the time for the release of labour shall be, so far as possible, regulated to the demand. Firms remaining in production, it was added, should be prepared to release their younger and more adaptable workers so as to make room for elderly workers displaced from other factories.

In the course of a reference to the new Schedule of Reserved Occupations, the writer of the Notes and Comments in the March issue of *Man and Metal*, the journal of the Iron and Steel Trades Confederation, says:—"Previously, a maintenance engineer in a lipstick factory was reserved solely on the ground that he was an engineer. In future, the reservation age of his occupation will only apply if he is employed on essential war work. Unless this is done, the reservation age is raised, and in some cases completely removed. A period of time is given before the higher reservation ages come into force, so that an opportunity will be given to those who wish to do so, to take up work in an essential trade. The new schedule does not affect to any great extent men employed in the iron and steel industry, although there is some modification in the reservation age of certain grades. The age for nearly all grades remains unchanged. This, of course, was to be expected in so vital and basic an industry as ours."

Commenting on the new arrangements for the employment of dock workers in the Merseyside, Manchester and Preston areas, Mr. Arthur Deakin, the acting general secretary of the Transport and General Workers' Union, says, in the March issue of the organisation's journal, the *Record*:—"Casual labour, which has so long been regarded as a blot upon our industrial system, disappears. In 1920, the Dockers' Inquiry presented Bro. Bevin with an opportunity to expose this evil; in 1924, the McLean Commission examined the problem and recommended the registration of port workers for the purpose of ending this pernicious exploitation of labour. In 1938, discussions again took place through the National Joint Council for Dock Labour, with a view to devising means for the establishment of a guaranteed week. Nothing resulted. Difficulties which could easily have been overcome prevented progress, and it is not overstating the facts to say that the failure to solve the problem in more peaceful times has increased our war-time difficulties in dockland. But it is not desirable at this time to enter into recriminations or apportion blame; both dockers and employers have accepted responsibility to put their best into the new scheme."

Writing on March 19, the New York correspondent of *The Times* stated that President Roosevelt has created a National Defence Mediation Board to assist in settling labour disputes in the defence industries. The tribunal is to be composed of four representatives of the workers, four representatives of the employers and three representatives of the public. Two of the Labour members belong to the American Federation of Labour, and two to the Committee for Industrial Organisation. The Board is empowered to act whenever the Secretary of Labour certifies a dispute as one which threatens to burden or obstruct the production or transportation of national-defence equipment and which cannot be adjusted by the Conciliation Service of the Labour Department.

The International Labour Review a publication of the International Labour Office, states that, according to *Isvestia*, the President of the Supreme Court of the U.S.S.R. has promulgated a Decree concerning the compulsory transfer of engineers, technicians, foremen, salaried employees and skilled workers from one undertaking or establishment to another. In an explanatory memorandum, the Decree points out that if the new undertakings, mines, etc., are to have their proper complement of specialists and skilled workers there must be a rational distribution of engineers, technicians, foremen and the like, among the different undertakings, and, if need be, workers must be transferred from one undertaking to another. Hitherto, the People's Commissaries have not had the right to make such transfers, and this has had, it is stated, a hampering effect on national economic development. Accordingly, the Decree empowers all the People's Commissaries to transfer to another undertaking, wherever its situation, engineers, foremen, technicians and other specialists, as well as skilled workers.

The transfer is not to have any material ill-effects for the person concerned. The Commissariat must pay him (*a*) his travelling expenses and those of his family; (*b*) the cost of transferring his property; (*c*) a daily travelling allowance; (*d*) his wages during the journey and six days' wages in addition; (*e*) compensation for installation expenses amounting to three or four times the monthly wage according to district, together with one-quarter of the monthly wage in respect of each member of the family accompanying him. A period of probation in employment is not to be deemed to have been interrupted by the transfer if the person concerned remains in the same region; if he is transferred to another region, the period of probation is to be extended by one year. Managers of undertakings and heads of establishments are required to authorise the wives of engineers, salaried employees and skilled workers transferred to another region to leave the undertaking or establishment in which they have been employed. Persons who refuse to carry out the Commissary's order concerning a compulsory transfer are to be deemed to be guilty of voluntarily leaving their employment and are liable to a penalty of imprisonment for from two to four months.

An interesting article on the employment situation in Germany has been contributed to the *Deutsche Verwaltung* by Dr. Syrup, of the German Ministry of Labour. The number of unemployed workers registered with the employment offices, which was 63,000 at the beginning of the war, is now, he says, only 32,000, and out of that number not more than one-tenth are employable. The number of workers on short time is only 2,000, and most of them are older women working in the textile industry. During the past year an additional 1,600,000 men have been made available for the war economy machine, including pensioners, workers who have agreed to postpone their superannuation and foreigners from every European country. Prisoners of war are not included in that figure. The number of women in employment fell by 500,000 from the outbreak of war until the beginning of February, 1940, since which date it has substantially increased and now exceeds the figure at the beginning of the war by 300,000.

The war has also led to a considerable increase in the number of foreigners employed in Germany. Whereas before the beginning of hostilities the total was about half a million, the figure is now about 1,100,000, and is increasing month by month. The number of prisoners of war employed in Germany is given as about 1,000,000.

THE HYDRAULIC EXTRUSION PROCESS.*

By C. E. PEARSON, M.A.

IT is probable that the earliest perception of the principles of extrusion was due to Joseph Bramah, the famous hydraulic engineer, who, in a patent granted in 1797, described a press shown in Fig. 1, page 258, "For making pipes of lead or other soft metals of all dimensions and of any given length without joints." Lead, maintained molten in an iron pot, *a*, by a fire beneath, was forced by a pump *b* into a long projecting tube *c*, which served as a die. A tapered mandrel *d* was supported concentrically within the tube by means of a bridge in its enlarged end. The lead passing through the annular space between the tube and mandrel was kept molten by the fuel gases inside the outer casing until it approached the outlet, where it was chilled to cause it to solidify, so that it emerged in the form of a pipe. Though it is doubtful whether this apparatus, which was devised to make pipes for the distribution of beer and similar liquors, ever operated satisfactorily, it claims attention as providing the first record of a machine which embodies a conception of the idea of extrusion, while it contains, too, the germ of the idea of die-casting.

There was no immediate development of Bramah's idea, and the earlier methods of making lead pipes by casting a hollow cylindrical billet, and either drawing this through holes in an iron plate, or rolling it on a mandrel between grooved rolls, continued to be used. It was not until 1820, when Thomas Burr, a Shrewsbury plumber, constructed a press operated by hydraulic power, that the manufacture of lead pipes by extrusion or, as it was then called, "squirting," came into actual operation. Burr's machine (Fig. 2, page 258) consisted of a strong cylindrical container *a* secured to the top frame of a hydraulic press, and having in its upper end a steel die *b*. The bottom end was sealed by a close-fitting plunger *c*, into which there was screwed a mandrel rod *d* attached to the hydraulic ram. After withdrawing the plunger to the full extent, lead was poured into the container through the die orifice, and, following an interval for solidification of the metal, the ram was operated to force the lead up through the die, to form the pipe. At the end of the stroke, the pipe was cut off above the projecting mandrel and hot lead was poured on to the remaining piece to melt it and clear the die. A difficulty was encountered, by no means unknown to-day, in securing pipe of uniform thickness in its wall, due to the mandrel becoming bent. By substituting a rectangular container provided with a slit aperture, Burr also made sheet lead. For this, one side of the die aperture was formed by a plate, adjustable by means of screws, so as to allow sheet of different thicknesses to be formed.

A modified press was made by J. and C. Hanson in 1837, in which the lead container was made the movable part by mounting it on top of the main ram of a hydraulic press, and a stationary plunger, attached to the head of the press frame, was used. The die was fixed in the bottom of the container, charging being done through a hole in the upper part of the container wall, which was sealed by the plunger at the beginning of the working stroke. Two features introduced to improve concentricity, which, especially the first, are retained in principle in certain types of press to-day, consisted in a means of centring the die by four adjusting screws; and in the use of a primitive form of bridge die, by which the long mandrel could be replaced by a short one *a* (see Fig. 3, page 258) held in a support of cruciform shape *b*, over which the stream of lead divided, to re-unite before actually entering the die. These arrangements are shown in Fig. 3.

The next noteworthy developments arose in the production of tin-lined pipes to convey corrosive liquors. This had been accomplished by running molten tin inside lengths of extruded pipe, but, in 1863, Shaw used a press in which pre-cast hollow billets of lead, with an internally-cast sleeve of tin, were charged cold into the container. Several billet presses of this kind were designed, but considerable difficulty was met in arriving at the correct shape of sleeve to give a uniform lining of tin. This is not to be wondered at in view of the complexity of the flow which is now known to occur, especially in the direct method of extrusion, which was solely used at that time.

A remarkable press for this work, invented in France by Hamon, in 1867, which embodies many advanced features, is shown in Fig. 4, on page 258. The principal points of interest are the use of a fixed mandrel bar *f*, into which could be screwed points *r*, of different sizes, over which the extrusion ram travelled; the container *b*, was made with ducts in its outer jacket through which steam or hot gases could be circulated to raise its

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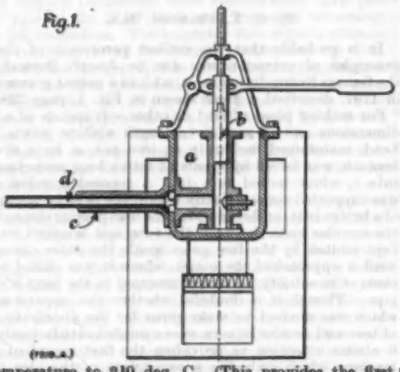
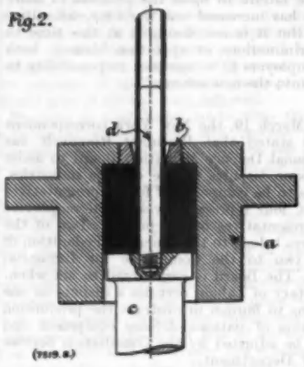
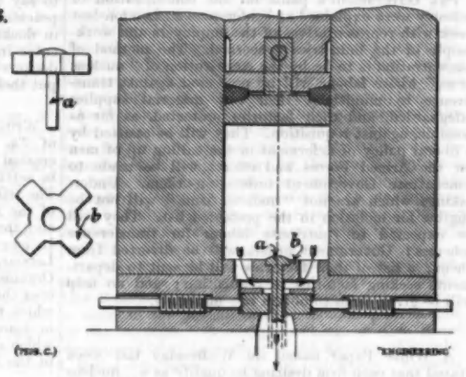
* Paper read before the Newcomen Society, at a meeting held at the Institution of Civil Engineers, London, S.W.1, on Wednesday, February 12, 1941. Abridged.

THE HYDRAULIC EXTRUSION PROCESS.







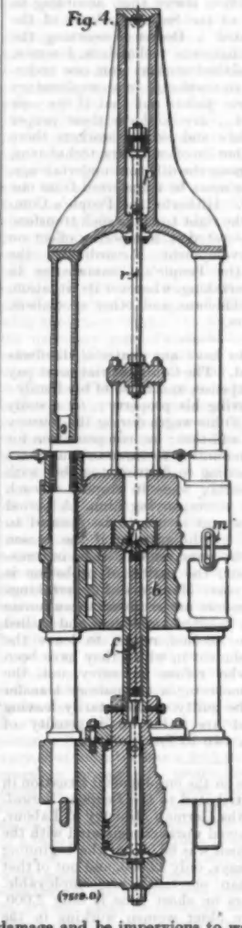
temperature to 210 deg. C. (This provides the first example of the use of a heated container; pointing out the necessity for careful adjustment of the temperature to avoid melting the tin sleeve, Hamon suggested the use of a pyrometer.); an auxiliary ram *p*, was used to bring the die *o*, and the die-holder *m*, into position against the container, where it was locked; and an accumulator was introduced into the hydraulic system. Although the hydraulic accumulator had been invented by Sir William Armstrong in 1840, it does not appear to have been used previously in connection with extrusion.

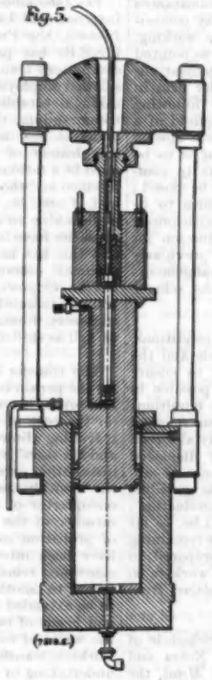
The next stage in the evolution of the pipe press came with the introduction by Haines, and by J. and W. Weems, both in 1870, of the indirect or inverted method of extrusion. On the application of this method to copper alloys at a much later date, it was shown to have the effect of so altering the course of deformation occurring in the billet as to obviate a characteristic defect in extruded material. The Weems claimed for the method that, since relative displacement of the billet and walls of the container was avoided, the metal remained undisturbed except near where it entered the die, and so made it possible to produce a more even coating of tin. A sketch of the Weems's press is given in Fig. 5, on this page. The die is fixed on the end of a stationary extrusion ram which is bored out to allow the passage of the extruded pipe, formed when the container is raised by the main ram to force the extrusion ram against the end of the billet. The lead may be cast into the container instead of using pre-cast billets, and when used in this way, the press has the advantage over the older ones, that the open-topped container allows dross to be skimmed off the surface of the metal.

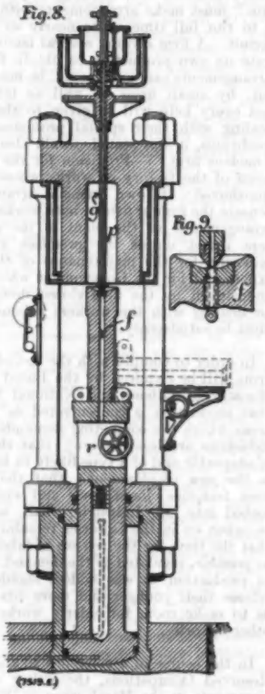
At the present time, the indirect extrusion press is used for the manufacture of lead pipes; the arrangement shown above is substantially that now in use. Some use of the process had also been made in the production of sheet and of special shapes, such as cames for leaded windows, by the use of dies of suitable form. For solid sections of simple shape, multiple-hole dies were commonly used. Moreover, there were extruded to a limited extent, in addition to the composite billets already referred to, other soft metals such as tin and solder alloys and even zinc. A series of ingenious devices for making curved lead pipes for use as syphons, bends, or traps, followed Curnyngham's original patent in 1873. Two representative examples are shown in Figs. 6 and 7, on this page. In Fig. 6, a casing *b*, containing a mandrel *c* and a sliding diaphragm *a*, was fitted to the end of an extrusion press. When the aperture of the diaphragm was centrally placed in the casing, lead delivered by the press could be extruded through the orifice at *d*, forming the die, as a straight pipe; but, by displacing the diaphragm laterally, a greater quantity could be passed to one side than the other, causing the issuing pipe to bend over to a desired curvature.

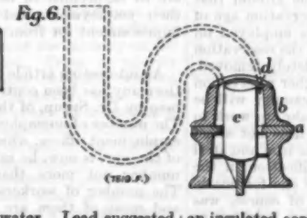
In an alternative machine, shown in Fig. 7, lead was poured into the cylinders *a*, *a*, of a steel casting, which were closed by two rams each connected with a hydraulic cylinder. The rams were advanced to force the lead, after it had solidified, through the semi-circular passages *b*, *b*, in which partition fins *c*, on the mandrel *d*, kept the two streams of lead separated until just below the die orifice, where they united to form a pipe in the annulus between the die and the mandrel. By controlling the speed at which the hydraulic rams moved forward, the operator could vary the rate of flow of lead on either side of the partition so that the greater volume passing through one side of the annulus produced a curved pipe. Bend presses of the latter type continue in common use.

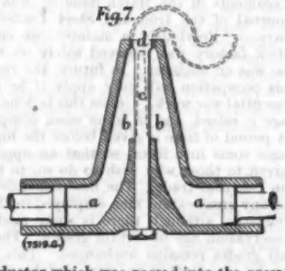
The rapid development of the electrical industry brought with it a need for a protective envelope for cables which would shield them against mechanical damage and be impervious to water. Lead suggested itself as almost the ideal material for this purpose. It had been used as early as 1845 by Wheatstone and Cooke in the form of a strip which was wound round the insulated conductor, and finally soldered along the overlapped edges. Subsequently, cable was threaded through 50-ft. lengths of ordinary lead pipe, which were then joined end to end by soldering. The cables were only loosely encased in this way and required to be tightened up by drawing or rolling. In a further method, a length of cable was laid out over rollers, with one end attached to the tip of the mandrel projecting through the die of a lead-pipe press, and lead pipe was then extruded over the cable. In 1879, there were devised by Borel, in France, and Wesslau, in Germany, the first methods by which a lead sheath could be directly extruded on to cables. In both cases vertical extrusion presses were used, in which hollow cast billets of lead were extruded as a tubular sheath over an insulated conductor which was passed into the press through a hollow mandrel and issued through the tubular ram. Figs. 8 and 9, on this page, show the general arrangement of the Borel press. With the ram *f* swung aside, a billet heated to 120 deg. C. was placed in the container *p*, and extruded as a tube through the annulus between a die carried on the nose of the extrusion ram and the conical end of a mandrel tube *g*. The latter moved with the extrusion ram, being connected to it by means of a crosshead (not shown in the diagram). The conductor entered the press via a bath of molten insulated wax, through the mandrel tube and, passing thence inside the lead pipe as it formed, emerged through the hollow extrusion ram, running finally over a pulley *r* to the coiling drum. Although it worked successfully, it had the disadvantage that a continuous length of cable could not be sheathed owing to the necessity of cutting it to allow a fresh billet to be inserted, and while this could



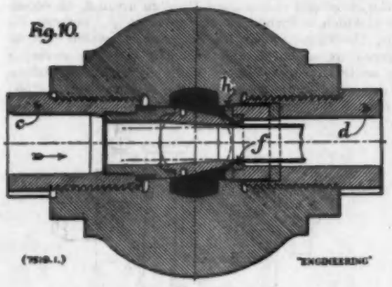


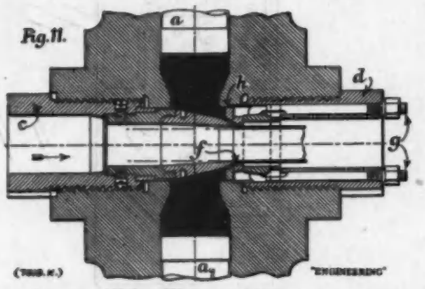


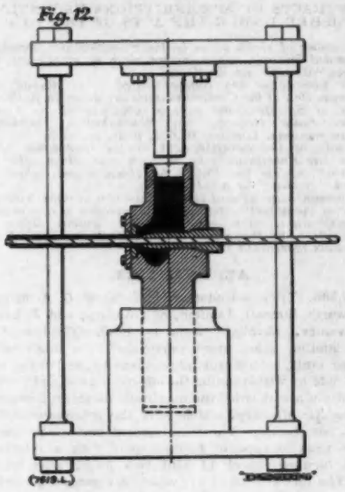


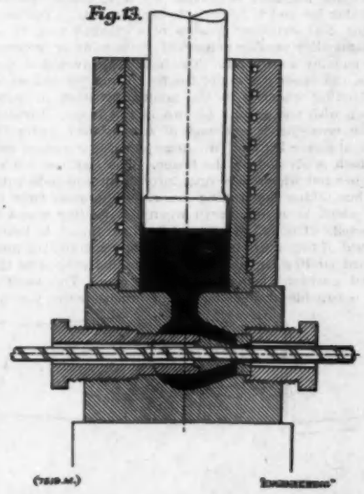


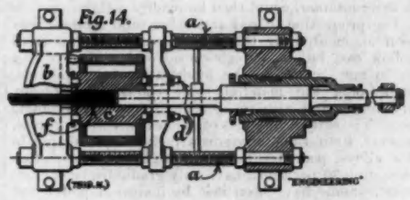
THE HYDRAULIC EXTRUSION PROCESS.

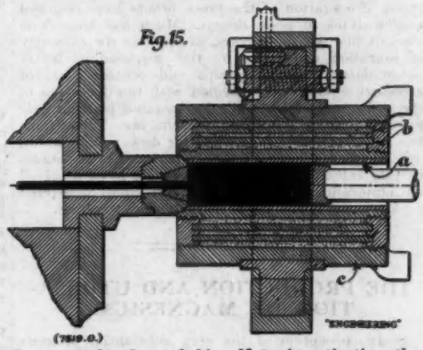












have been avoided by casting the charge of metal in the container, it was apparently considered impracticable because of the damage which the high temperature would have caused to the insulation where the cable passed through the mandrel during filling.

Two years after this, there was brought out by Huber, in Germany, a press operating on the same principle as a lead-bend press, having two hydraulic rams, a, a_1, Figs. 10 and 11, herewith, acting in cylinders opposite to one another, to force lead into a die-block placed between them. Holders c, d carrying the hollow mandrel or point holder through which the cable entered at right angles to the axis of the container and the die f and base ring h, were screwed into the back and front of the die block, respectively. In addition to the longitudinal adjustment by means of the screwed holder, the die could also be moved laterally by four wedge bolts, g, to afford a means of controlling the concentricity of the sheath. The two cylinders, heated by an oil-fired furnace beneath, were filled with lead through openings in their wall, at a point farthest from the die block, from a melting pot set in a furnace on top of the press, after which the press rams were moved forward sufficiently to expel air and some of the dross carried in with the lead, and then to seal the filling holes. When the lead had solidified, the rams, set to provide equal pressure by an equalising valve, were operated to drive it round the point holder, where the two streams met at the top and bottom of the latter, flowing forward subsequently through the die aperture as a sheath over the cable, which was thereby drawn through the press. These machines met with considerable success. Large units, up to 5,000 tons total pressure, were in operation by the beginning of this century and their use has only recently been abandoned. The chief difficulty appears to have been in maintaining an even flow of lead from each container, due to small differences in temperature between the latter and thus in the plasticity of the metal.

Concurrently with the development of the horizontal press just described, there was evolved a vertical cable press, which had its origin in America with the design, in 1880 by Eaton, shown in Fig. 12, on this page, having been adapted from the ordinary pipe press. A charge of lead cast and solidified in the container was made to flow circumferentially round a mandrel set transversely across the bottom of the container and was extruded, at right angles to the axis of the latter, over a cable threaded through the mandrel. This press was much improved in 1885 by Robertson, who made a special block to hold the die and mandrel, upon which the now separate container rested. The general arrangement of the vertical cable press as it has evolved from this is shown in Fig. 13.

The advanced state to which extrusion had been brought in the service of the lead industry naturally directed attention to the possibility of its utilisation for other metals possessing better mechanical properties, such as the brass alloys. The difficulties, at first, proved too great, and the lead presses which were, in many cases, used for experiment, were unsuitable. A report of one trial states surprisingly that "it was anxiously and unexpectedly found that when the brass block came to be subjected to pressure, the zinc left the copper, thereby producing a zinc pipe and leaving the copper behind . . . proving that the atoms of brass composition, united by fusion, were only mechanically arranged, not chemically combined." The main difficulty was that even the brasses most susceptible to hot work do not become sufficiently plastic to undergo the heavy deformations involved in extrusion until they are heated to a temperature of at least 600 deg. C. The question also arose of providing dies, containers and other parts of composition and design to withstand the unusually severe thermal and stress conditions, and that at a time when little development of the special steels now available for such service had taken place. It is hardly possible, therefore, to over-estimate the achievements of Alexander Dick in successfully overcoming the obstacles involved. On his inventive genius has been laid the foundation of the modern hot-extrusion process, now extended far beyond its original limitations to a stage where it covers most of the technical non-ferrous alloys, and where it has become one of the major metal-working processes in the field.

George Alexander Dick* was born in 1837 at Offenbach-am-Main, in Germany, his father being of Scottish descent and his mother English. After studying under Fresenius, Bunsen and Kirchoff, he became an analytical chemist in a German iron works, and was subsequently appointed blast-furnace manager to a works in Spain. Later, with his brother, C. A. J. Dick, he opened up a general engineering business in Paris, which was successful until the outbreak of the Franco-German War of 1870, when he settled in England where, with others, he founded the Phosphor Bronze Company of London, which he managed until 1881. For the next few years he devoted himself to investigating the possibilities of other copper alloys and to improving the brasses. The benefit of adding iron to brass had already been found by Baron Rosthorn in Austria, but difficulty had been met in introducing it into the alloys. Dick discovered that this could be done with certainty by the use of an iron-zinc alloy. He finally began the manufacture of some of these alloys under the name of Delta metal, converting his business, in 1888, into the Delta Metal Company, Limited. After making a study of the behaviour and flow of copper alloys in connection with the production of stampings and pressings, he became interested in the idea of making rods, tubes and sections by cheaper processes than those of rolling and drawing, and, after preliminary experiments in a small vertical hydraulic press, he was eventually successful in extruding certain brasses and other copper alloys, and started to manufacture by the process in London, Birmingham and Düsseldorf. He continued to improve his inventions up till his death on September 18, 1903.

Dick's first patent for an extrusion press was obtained in 1894, and was followed in the next few years by several others. One of his early designs is shown in Fig. 14, herewith. The horizontal press frame was braced together by four tie rods a. A heavy crosshead b formed one end of the press and supported the die which was held in position against the container by a pair of jaws, pivoted at the base of the crosshead. The container c, held and centred by the setscrews d, was surrounded by a furnace jacket heated by coke or gas. The billet f, heated to a plastic state, was fed into the container from the front. To prevent the ram from becoming wedged by the escape of metal past its sides, a dished or corrugated disc was placed between it and the billet. At the end of the extrusion, the jaws were opened to allow the die and unextruded remnant to be pushed out. A persistent source of trouble was encountered in that the heat given up by the billet caused unequal heating of the thick-walled container, so that it frequently cracked. To meet this, compound containers were introduced. One of the first of these, shown in Fig. 15, on this page, has a thin tapered inner liner a surrounded by casings b, b, with the annular space between them packed with some such material as crushed granite or asbestos to afford heat insulation, the whole being encased in the strong outer shell c. The idea of this was that the inner liner would suffer less damage from heat stresses than a thicker one, and could be easily replaced, while the outer shell, being at a much lower temperature, retained its strength. This construction did away with the need for external heating of the container, though it had to be warmed up to begin with by a gas burner or by inserting a hot block of iron. For a time, as an alternative to the use of preheated billets, the practice was also followed of casting the metal directly in the container, which was mounted for this purpose on trunnions so that it could be turned into an upright position for casting. A plate closed the bottom of the container during this operation. An improved method of supporting the die in a holder placed in a diehead, as seen in Fig. 15, was soon adopted, and this assembly was locked during operation by a transverse slide buttressed against the crosshead of the press. The

* For the above biographical details, the author is indebted to Mr. Henry Rogers, M.B.E.

diagram also shows the use of a loose follower block behind the billet. This could be preheated to avoid cooling the billet; the ram, being made with a clearance in the container, could then be readily withdrawn.

The production of rod and other solid sections was soon augmented by the manufacture of tubes from hollow cast billets, though considerable difficulty had to be met, owing to the inadequate steel available, in keeping the mandrels cool enough to prevent breaking; and also in securing tubes of concentric bore. The early drawbacks of the hot-extrusion process, namely, limitation to comparatively simple shapes in few alloys, poor accuracy, and high scrap loss, often exceeding 30 per cent., have only gradually been overcome. Some have been met by increased power and speed of operation of the press, others have required modifications in press design. Much has been done also, in the past forty years, to improve the efficiency of extrusion machinery by the provision of better accumulator systems, pumps and control gear, of accessory equipment connected with the operation of the press, and of hydraulically-operated piercing gear for the production of hollow sections, etc. The advent, too, of chrome-tungsten steels for dies, mandrels and other tools has been of major importance. The stages in this subsequent progress, however, have involved no significant departure from the principles discovered by Dick, but rather the perfecting of his methods.

THE PRODUCTION AND UTILISATION OF MAGNESIUM.

SOME conception of the very substantial progress made last year by the magnesium-producing industry of the United States may be obtained from the perusal of a brief statistical survey on the subject, prepared by Messrs. H. A. Franke and M. E. Trought, and issued recently by the Bureau of Mines at Washington. It is stated therein that the production of magnesium in the United States during 1940, namely, 5,580 long tons, was not only greater by 87 per cent. than the output for 1939 (2,991 tons)—itself a high record at the time—but was the highest total reached in the history of the industry. Moreover, the Dow Chemical Company, which is described as the only producer of magnesium in the United States, expects to produce 13,400 tons of the metal during the present year. In February, 1940, this company doubled the capacity of its plant at Midland, Michigan, in which the metal is extracted from magnesium chloride derived from underground brine. Furthermore, last January, production was commenced at a newly erected plant at Freeport, Texas, in which the magnesium is extracted from sea water. In addition, this Company has extended its foundry, extruding and other installations, and the American Magnesium Corporation has decided to triple its output of fabricated magnesium.

The great increase in the consumption of the metal and its alloys in 1939 and 1940, as compared with 1938, is attributed to the national defence programme. Not only did the aircraft industry, the principal user of the metal in the United States, embark upon an extensive programme of construction, but it began to increase the range of the utilisation of magnesium-base alloys. Moreover, the motor-car, textile, and other industries, and those engaged in the manufacture of portable and high-speed tools, all increased their consumption of the metal. The munitions industries also employed greater quantities of magnesium powder in the manufacture of tracer bullets, star shells and flares, and the enlarged production of certain metals and alloys resulted in greater demands for the metal as a deoxidiser and scavenger in the metallurgical industry.

While official data are not available, it is believed that the total output of magnesium in the world, during 1940, was in the neighbourhood of 45,000 short tons. The principal producing countries of the metal in 1940, in apparent order of importance, are quoted as being Germany, the United Kingdom, the United States, Japan, France, the U.S.S.R., Italy, and Switzerland. According to sources which are believed to be reliable, production in Germany was between 18,000 and 21,000 short tons in 1940. Germany employed carnallite, a potassium-magnesium chloride mineral occurring in the Stassfurt salt mines in Saxony; potash end-liquor; and magnesite and dolomite as the raw materials for the production of magnesium. It is stated that the electrolytic magnesium-chloride process has been employed, but that experiments on the direct thermal reduction of magnesium oxide have recently been put in hand. Owing to the scarcity of other metals, Germany is said to employ magnesium alloys for the manufacture of parts for telephone switches, optical instruments, microscopes, 'bus bars, motor cars, tramway cars and military vehicles and equipment. Further, in the manufacture of plates for the engraving industry, copper-zinc alloys have been replaced by magnesium alloys.

"ENGINEERING" ILLUSTRATED PATENT RECORD.

ABSTRACTS OF SPECIFICATIONS RECENTLY PUBLISHED UNDER THE ACTS OF 1907 TO 1939.

The number of views given in the Specification Drawings is stated in each case; where none is mentioned, the Specification is not illustrated.
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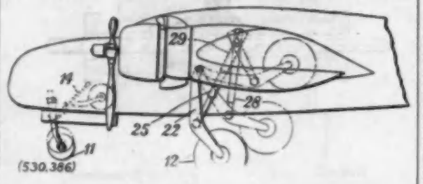
Any person may, at any time within two months from the date of the advertisement of the acceptance of a Complete Specification, give notice at the Patent Office of opposition to the grant of a Patent on any of the grounds mentioned in the Acts.

AERONAUTICS.

530,386. Tricycle Undercarriage. Sir W. G. Armstrong Whitworth Aircraft, Limited, of Coventry, and J. Lloyd, of Coventry. (5 *Figs.*) June 10, 1939.—The invention is a landing gear, more particularly for high wing-loading craft, which will allow them to be landed in a small field by withstanding the effects of a vertical landing velocity of about twice the maximum at present required by the Air Ministry, which is in the neighbourhood of 12 ft. per second. The twin-engined monoplane shown has a tricycle type of landing gear with a relatively small forward wheel 11 and two larger rear wheels 12. The forward wheel 11, which is arranged according to normal practice, is carried by a hydraulic shock-absorbing leg and is retractable by a jack 14. The rear landing gear structure consists of a cranked fork 22 of two light-alloy castings connected about midway between their ends by a cross-pin. The fork 22 is pivoted on the frame, the upper portion of the fork being vertical when the landing wheel is in the landing position prior to impact with the ground (shown in full lines). Pivoted to the cross-pin is one end of a combined hydraulic shock-absorber leg and two-stage jack 25, the other end of which is pivoted on the frame. The jack consists of an inner rod which telescopes into an intermediate tube 28 when taking the landing shock, and an outer tube 29 into which both are drawn when the landing wheel is retracted. The initial upward landing thrust is taken forward of the centre of gravity of the machine, the final upward landing thrust (when the landing gear is in the loaded position) being well to its rear. The landing gear is capable of allowing a very much greater vertical



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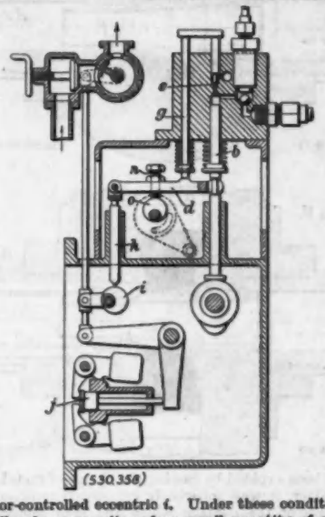
movement than has been allowed for up to the present time. In landing an aeroplane fitted with this landing gear, the 'plane is allowed to glide, with flaps down to give lift, at approximately 20 per cent. above the stalling speed directly on to the landing ground, or with only a slight flattening out. When the main landing wheels touch the ground the landing thrust, as stated, is forward of the centre of gravity so that excessive loading of the front landing wheel 11 is avoided. As the main landing gear collapses, however, the line of thrust passes to the rear of the centre of gravity, and the forward wheel therefore comes into action in the ordinary way. Immediately upon impact, the flaps are swung back and other flaps are raised so that the lift is reduced and the wheel brakes are given their maximum effectiveness. The landing gear illustrated is capable of dealing with a vertical velocity of approximately 25 ft. per second, which may be required to be dealt with if the machine is being landed without any flattening out. The shock-absorbing leg is designed to carry twice the normal load and have twice the usual movement. In this way the vertical movement allowed to the centre of gravity of the machine during the landing impact is approximately four times that ordinarily allowed—the vertical movement necessary being a function of the square of the vertical velocity. (*Accepted December* 11, 1940.)

INTERNAL-COMBUSTION ENGINES.

530,358. Gas or Oil-Driven Engine. Crossley Brothers, Limited, of Manchester, and H. D. Carter, of Manchester. (1 *Fig.*) June 22, 1939.—The invention is a compact and self-contained change-over unit for internal-combustion engines of the type which work on the compression-ignition cycle as oil engines, or compress gas or a gas and air mixture which is ignited by oil injection at the point of maximum compression. Efficient governor control of the engine is maintained under all conditions of working. The camshaft operates the constant-stroke oil-pump plungers *b* through tappet levers *d*, each of which operates a spill valve *e* through the rod *g*. The tappet lever is moved at one end by the camshaft and at the other end can engage, through a rod *h*, an eccentric *i*, which is turned by the governor *j*. Between its ends, the tappet lever has a screw *n*, which can be engaged by an adjustable eccentric *o*. The governor also controls the gas inlet. When the engine is working on gas with pilot oil ignition, the eccentric *o* is turned to engage the screw *n* and hold the rod *h* clear of the



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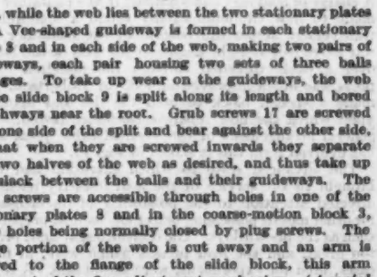
governor-controlled eccentric *i*. Under these conditions, the spill valve *e* permits only a small quantity of oil to be injected for ignition purposes. The gas supply is under continuous governor control. When the engine is working as a compression-ignition oil engine, the gas valve is closed, and the eccentric *o* turned to clear the screw *n*, so that the rod *h* contacts with the eccentric *i*, which puts the spill valve under continuous governor control. The engine can be arranged to run with part oil and part gas as fuel. (*Accepted December* 10, 1940.)

MISCELLANEOUS.

525,970. Ball-Bearing Microscope Slides. Cooke, Troughton and Simms, Limited, of York, and E. W. Taylor, of York. (5 *Figs.*) March 3, 1939.—The invention is a ball-bearing type of slide for a microscope which eliminates the difficulties of manufacturing a number of accurate guideways and of clamping them to ensure even contact pressure on all the balls. To the main limb 1 of the microscope is bolted a dovetail guide 2 for a coarse-adjustment sliding block 3 which supports the microscope body tube 4 and houses the fine adjustment mechanism. Coarse adjustment is made by a pinion within the block which meshes with a rack on the dovetail guide 2. The block 3 has secured to it adjacent the tube 4, a pair of vertical plates 8, and between them works the fine-motion slide block 9. This block carries the nose piece bracket for the tube 4, and is generally of T-section, the flanges closing the front of the fine-motion



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slide, while the web lies between the two stationary plates 8. A Vee-shaped guideway is formed in each stationary plate 8 and in each side of the web, making two pairs of guideways, each pair housing two sets of three balls in cages. To take up wear on the guideways, the web of the slide block 9 is split along its length and bored lengthways near the root. Grub screws 17 are screwed into one side of the split and bear against the other side, so that when they are screwed inwards they separate the two halves of the web as desired, and thus take up any slack between the balls and their guideways. The grub screws are accessible through holes in one of the stationary plates 8 and in the coarse-motion block 3, these holes being normally closed by plug screws. The centre portion of the web is cut away and an arm is secured to the flange of the slide block, this arm being part of the fine-adjustment mechanism. (*Accepted September* 9, 1940.)